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PHYSICS.—*Transients in signal analysis.*[1]

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Every signal analyzing system has some limiting inertia in its response; even in the ideal limit a certain amount of inertia is required to produce the needed degree of frequency or power level resolution. The error introduced may be represented by a limiting volume in a space whose Cartesian coordinates are frequency, time, and either power or a function of power. The transient error then becomes a least volume in this space, within which no information about the signal can be found. The experimenter cannot eliminate the transient error, but by choice of experimental conditions the distribution of errors can be controlled.

Regardless of whether a frequency or a time-correlation analysis of a signal is undertaken, the results are observed as output power levels. Hence the ability to resolve a change in power levels limits the discrimination that can be achieved for changes in frequency or intervals of time. The quantitative extent to which power level resolution affects resolution along the coordinates of frequency and time can be found from the natural properties of the analyzer. The discussion here is based on the common type of system whose behavior is described by a second-degree differential equation with constant coefficients.

In a previous paper (Corliss, 1955) we discussed the relationship between "figure of merit," Q, observation time interval, $\Delta\tau$, and power level discrimination, α, when the behavior of a linear series-resonant filter was adjusted to satisfy the condition that an analyzer should be able to change its indication by a factor of at least $e^{-\alpha}$ during the time interval $\Delta\tau$. From these considerations it followed that

$$Q \leqslant \frac{2\pi f_0 \Delta\tau}{\alpha} \tag{1}$$

and

$$\Delta f \Delta\tau \geqslant \frac{\alpha^{3/2}}{2\pi}. \tag{2}$$

Given that $\Delta\tau$ is the briefest duration of any signal component to be observed, Equation (1) shows how the Q of a filter must be adjusted as a function of its tuning in order to distribute the transient error uniformly over the frequency range.

Equations (1) and (2) also provide a measure of the largest number of band-pass filters that can be overlapped on adjacent channels to yield meaningful information about a rapidly changing signal.

Over a range of frequencies $\Delta f = f_u - f_l$ surrounding f_0, the frequency to which the filter is tuned, the change in filter response does not exceed the smallest detectable power level change. For a set of filters overlapped at these limits of power resolution, the limiting number of filters yielding meaningful information between f_t and f_b, the high- and low-frequency range limits, respectively, is given by

$$n_l - 1 \leqslant \frac{f_t - f_b}{\Delta_f} = \frac{2\pi\Delta\tau}{\alpha^{3/2}} (f_t - f_b).$$

(The limits yield $n_l - 1$ rather than n_l be-

[1] This work was part of a program of basic instrumentation research and development supported by ONR, AEC, AFOSR, and NBS.

cause one-half of a filter extends beyond each end of the frequency range as defined here.)

A common practice in using parallel channels of band-pass filters is to overlap adjacent filters at their half-power points, so that their integrated response has a flat characteristic. For this condition, $\Delta f = f_0/Q$ and the number of filters becomes

$$n_2 - 1 = \frac{f_t - f_b}{\Delta f} = \frac{2\pi\Delta\tau(f_t - f_b)}{\alpha}.$$

The ratio of this number to the maximum usable number of filters depends only on the power level resolution, i.e.,

$$\frac{n_2 - 1}{n_1 - 1} = \alpha^{1/2}.$$

If we are willing to take a "yes-no" type of analysis from the filter, then for a set of filters overlapped at their half-power points we can choose as a compatible condition that $\alpha = \ln 2$, i.e., the power declines at least to one-half its initial value during the observation interval $\Delta\tau$ and we get as the number of filters for this case

$$n_b - 1 = \frac{2\pi\Delta\tau(f_t - f_b)}{\ln 2}.$$

Under these conditions n_b invites comparison with the number of "bits" available in a given bandwidth during the time interval $\Delta\tau$.

By scanning the tuning of a filter, the spectrum of a signal can be studied by means of a single metering channel. When one scans by sweeping the tuning of a filter over the frequency range to be covered, the filter shows a rather complicated response.[2] One can, however, obtain quantitative results from simple theory by recognizing that an additional multiplicative factor must be used to account for the spreading of the filter's transient response caused by scanning. The spreading occurs because the incoming signal beats with the ringing of the filter. In the following discussion, the spreading factor is omitted.

The functioning of a scanning filter can be compared with a parallel channel set of band-pass filters by calculating the effective number of band-pass filters that will provide the same resolution as the scanning filter.

Various types of scanning functions can be used depending upon the nature of the selectivity characteristic desired. If one wishes to have a constant Q (constant percentage bandwidth), the condition that the transient error is to be uniform throughout the range of frequencies swept over can be satisfied by scanning at a rate proportional to the square of the instantaneous

[2] Lewis, 1932; Hok, 1948; Barber and Ursell, 1948; Marique, 1952; Herrero, 1953; Batten et al., 1954.

SCANNING RATE	Q FIGURE OF MERIT FOR SELECTIVITY	(n_2-1) NUMBER OF FILTERS OVERLAPPED AT HALF-POWER POINTS	K SCANNING PARAMETER	$\Delta\tau$ OBSERVATION INTERVAL
NO SCAN	$\leq \frac{2\pi f_0 \Delta\tau_0}{\alpha}$	$\frac{2\pi\Delta\tau_0(f_t-f_b)}{\alpha}$	0	$\Delta\tau_0 = \frac{\alpha Q}{2\pi f_0}$
UNIFORM SCAN $\frac{df}{dt}=k$	$\leq \sqrt{\frac{2\pi\tau}{\alpha(f_t-f_b)}}\, f_0$	$\sqrt{\frac{2\pi\tau(f_t-f_b)}{\alpha}}$	$\frac{f_t-f_b}{\tau}$	$\frac{\alpha\tau}{2\pi(f_t-f_b)}$
LOGARITHMIC SCAN $\frac{df}{dt}=kf_0$	$\leq \sqrt{\frac{2\pi\tau}{\alpha \ln(f_t/f_b)}}\sqrt{f_0}$	$2\sqrt{\frac{2\pi\tau}{\alpha \ln(f_t/f_b)}}\,(\sqrt{f_t}-\sqrt{f_b})$	$\frac{\ln(f_t/f_b)}{\tau}$	$\frac{1}{\sqrt{f_0}}\sqrt{\frac{\alpha\tau}{2\pi \ln(f_t/f_b)}}$
QUADRATIC SCAN $\frac{df}{dt}=kf_0^2$	$\leq \sqrt{\frac{2\pi\tau}{\alpha(1/f_b-1/f_t)}}$	$\sqrt{\frac{2\pi\tau}{\alpha(1/f_b-1/f_t)}}\ln\frac{f_t}{f_b}$	$\frac{1/f_b-1/f_t}{\tau}$	$\frac{1}{f_0}\sqrt{\frac{\alpha\tau}{2\pi(1/f_b-1/f_t)}}$

center tuning of the filter. When one wishes to scan through the frequency range with a filter whose bandwidth is a constant number of cycles per second, this implies a Q directly proportional to the center tuning of the filter and a uniform transient error results from scanning at a constant rate, independent of frequency. A commercial scanning filter, the Panoramic Analyzer, sweeps logarithmically over its frequency range; when it is adjusted to uniform transient response, its instantaneous Q is proportional to the square root of its instantaneous tuning. This gives a range of Q with frequency which is intermediate between constant frequency bandwidth and constant percentage bandwidth.

The accompanying table (p. 306) summarizes the results of calculations on the basis of a uniform distribution of transient power level discrimination error, i.e., α = constant. The table gives Q, the figure of merit, k, the scanning rate parameter, and n_2, the equivalent number of filters overlapped at their half-power points, in terms of the scanning time τ, the scanning bandwidth limits f_h and f_l, and the time-attenuation parameter α. To facilitate adjustment of the response time of an analyzer to the least duration of any signal component to be observed, the tabulation also includes $\Delta\tau$, the observation time interval for a single filter.

Similar considerations apply to the requisite integration times of correlation analyzers. For a synchronous detector equipped with an R-C integrator of time-constant τ, the equivalent Q for a synchronous period T is given by

$$Q_0 = \frac{\pi\tau}{T}.$$

This result is due to Selgin (1951).

REFERENCES

BARBER, N. F., and URSELL, F. *The response of a resonant system to a gliding tone.* Philos. Mag. **39:** 345–361. 1948.

BATTEN, H. W., JORGENSEN, R. A., MACNEE, A. B., and PETERSON, W. W. *The response of a Panoramic Analyzer to CW and pulse signals.* Proc. Inst. Radio Eng. **42:** 948–956. 1954.

CORLISS, EDITH L. R. *Limiations on rapid signal analysis.* Journ. Washington Acad. Sci. **45** (11): 359–360. 1955.

HERRERO, M. C. *Resonance phenomena in time-varying circuits.* Electronics Res. Lab. Stanford Univ. Techn. Rep. no. 69. 1953.

HOK, G. *Response of linear resonant systems to excitation of a frequency varying linearly with time.* Journ. Applied Phys. **19:** 242–250. 1948.

LEWIS, F. M. *Vibration during acceleration through a critical speed.* Trans. Amer. Soc. Mech. Eng. **54:** 253–261. 1932.

MARIQUE, J. *The response of RLC resonant circuits to EMF of sawtooth varying frequency.* Proc. Inst. Radio Eng. **40:** 945–961. 1952.

SELGIN, PAUL. *Harmonic output of the synchronous rectifier.* Journ. Res. Nat. Bur. Standards **47:** 427–432. 1951.

NEWS OF MEMBERS

Dr. G. Arthur Cooper has been appointed head curator of the Department of Geology of the U. S. National Museum, Smithsonian Institution, succeeding the late Dr. William F. Foshag. Dr. Cooper will continue to serve as curator of invertebrate paleontology and paleobotany. He is a former senior editor of this JOURNAL.

Dr. Ferdinand G. Brickwedde, former secretary of the WASHINGTON ACADEMY OF SCIENCES, chief of the Heat and Power Division of the National Bureau of Standards, is the new dean of the College of Chemistry and Physics at Pennsylvania State University.

PALEONTOLOGY.—*An acanthodian fish from the lower Permian of Texas.*[1]

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(Received August 16, 1956)

While engaged in U. S. Geological Survey field work during the Spring of 1955 Mamay, accompanied by E. L. Yochelson, collected the complete remains of a small acanthodian fish. The specimen and the details of its occurrence seem of sufficient interest to warrant a published account, particularly since, insofar as we are aware, no other complete specimens have yet been recorded from the Permian of the Western Hemisphere.

The fossil was found in an outcrop on the Emily Irish land grant, approximately 18 miles south-southeast of Seymour, in Baylor County, Tex. According to the revised geologic map of Baylor County, published in 1937 by the Texas Bureau of Economic Geology, this outcrop lies within the boundaries of the Belle Plains formation of the lower Permian Wichita group. The exact position of the fossiliferous horizon within the Belle Plains formation is uncertain. However, it is mapped as lying beneath an unnamed limestone member which itself is overlain by the Beaverburk limestone member of Garrett, Lloyd, and Laskey (1930) of the Belle Plains formation. From these facts, the bed is presumed to be a correlative of the Valera shale member, which occupies a position at about the middle of the Belle Plains formation in Coleman County, Tex., 120 miles to the south.

On a cosmopolitan basis, fossil remains referred to the Acanthodii present a maximum stratigraphic range of from upper Silurian to lower Permian. Nielsen (1932) has reported fragmentary acanthodian fossils from the lower Permian of East Greenland. However, the youngest previous record of this group of fishes in the United States known to us is from the Middle Pennsylvanian: *Acanthodes* (*Acanthoessus*) *marshi* Eastman (1902) and *A. beecheri* Eastman (loc. cit.). The newly reported discovery thus provides definite evidence that the distribution of this group of placodermatous fishes is much the same in the Western Hemisphere as in the Eastern.

The fish (U.S.N.M. no. 21318) is scaleless and impressed as little more than a rusty carbonaceous film on a dark grey and very fine-grained shale. Recovered in part and counterpart, the body outline and fin positions are clearly discernible, nonetheless, and the gross characteristics of the form can be determined.

As preserved, probably lacking some small portion of the epichordal lobe of the caudal fin, the specimen possesses an axial length of about 37 mm and a maximum body depth of 4.5 mm. A very slenderly fusiform body habit is thus displayed. Reflecting the general body shape, the head is also slender and long; its length from snout to origin of the pectoral spine apparently contained 4½ times in the overall axial length of the specimen. The position of the orbits are exhibited and a trace of either the preopercular or opercular sensory canal is preserved. Unfortunately, no other structures of the skull or branchial apparatus can be determined.

Fin positions are denoted by the impression of delicate spines which are extremely narrow relative to their lengths. No tissue of this armament remains but the impressions show each to have been marked by one longitudinal groove along the side. Dorsal and anal fin spines are single, situated very far posteriorly with the larger anal one slightly in advance. The heterocercal caudal fin is indicated to be moderately clefted and with the hypochordal lobe appreciably shorter than the dorsal body extension. Neither pectoral nor pelvic spines are preserved in their entirety. The pectoral one, however, is noticeably more robust and presumably longer than the pelvic. The latter is inserted nearer the pectoral appendage than to the anal.

[1] Published with the permission of the Secretary, Smithsonian Institution, and the Director, U. S. Geological Survey.

FIG. 1. *Acanthodes* sp. (U.S.N.M. no. 21318): Photograph of specimen as exposed in lateral view. × 4.

This combination of characteristics is that of the genotypic material of *Acanthodes* from the Rotliegende of Lebach, Germany. While probably distinct from the Middle Pennsylvanian forms from Illinois mentioned above (Eastman, 1902, and Gregory, 1951), no species assignment is made for this specimen from Texas. Woodward (1891) customarily grouped all of the *Acanthodes* from Lebach under *A. bronni* Agassiz. Watson (1937) called attention to the wide differences between the numerous series of Lebach specimens. The variants, however, were left unnamed because of either the difficulty or impossibility of locating the Agassiz types. Therefore there seems to be no adequate basis, as yet, of evaluating material falling within such a range of variation, or for making a specific identification of the presently discussed specimen.

The specimen was found in association with an extremely rich and diverse terrestrial floral assemblage, description of which is currently being prepared for publication by Mamay. The flora is dominated in large part by pecopterid ferns of the type that was prevalent in Late Pennsylvanian coal swamps. However, various callipterids, sphenopterids, *Tingia*-like foliage and *Gigantopteris americana* White also constitute conspicuous elements in the flora, with lycopsids and sphenopsids showing only a minor representation.

Although this shale bed contains a great profusion of plant remains, animal fossils are by contrast extremely rare. The most common of these are estherid remains, which occasionally occur in fairly rich local concentrations. However, the fish specimen under discussion represents the only vertebrate fossil found by the collectors although perhaps as much as three cubic yards of matrix was split and carefully examined; furthermore, a large collection made in 1940 by Charles B. Read of the U. S. Geological Survey at the same locality is completely lacking in vertebrate remains.

Both the abundance and condition of the plant material suggest deposition of the enclosing sediments in relatively quiet, undisturbed, fresh or possibly brackish water. Although the matrix is very friable and must be handled carefully, it has been possible to expose many large and unbroken leaf specimens. The state of preservation of this delicate foliage discourages the possibility that it could have been subjected to transportation over considerable distances from its original habitat, or to much agitation in the waters in which it was deposited. It is

quite likely, then, that the fossiliferous bed represents the bottom of a quiet pool or an extremely sluggish stream.

REFERENCES

EASTMAN, C. R. *Some Carboniferous cestraciont and acanthodian sharks.* Bull. Mus. Comp. Zool. **39**(3). 1902.

GARRETT, M. M., LLOYD, A. M., and LASKEY, G. E. Texas Bureau of Economic Geology, Map of Baylor County. 1930.

GREGORY, J. T. *A new specimen of* Acanthodes marshi. Bull. Southern California Acad. Sci. **50**(1). 1951.

NIELSEN, E. *Permo-Carboniferous fishes from East Greenland.* Medd. Grønland **86**(3). 1932.

WATSON, D. M. S. *The acanthodian fishes.* Philos. Trans. Roy. Soc. London, ser. B., **228**(549). 1937.

WOODWARD, A. S. *Catalogue of fossil fishes in the British Museum*, pt. 2. 1891.

MAUNA LOA OBSERVATORY

A unique high-altitude observatory on the slope of the Hawaiian volcano, Mauna Loa, was dedicated on June 28 for joint use by the National Bureau of Standards and the U. S. Weather Bureau. Located at a height of 11,134 feet in the Tropics, where the upper atmosphere is very clear and usually of low moisture content, the new observatory offers special advantages for many types of astronomical and upper-air studies. It will make possible continuous observation of atmospheric phenomena with manned instruments in place of the unmanned meteorological balloons that have been used for the most part in high-altitude work.

The dedication ceremonies were arranged by R. L. Fox of the Weather Bureau, and J. B. Cox, president of the Geophysical Society of Hawaii, acted as master of ceremonies. After introductory remarks by Governor S. W. King of Hawaii, J. W. Steiner of the Weather Bureau gave some highlights on the new facility. Ralph Stair and C. C. Kiess of NBS then spoke on research potentials of the observatory and its use in studying the planet Mars. Prof. W. B. Steiger of the University of Hawaii commented on the importance of the observatory to geophysics, and Mr. Fox discussed the past, present, and future of the observatory.

The new observatory is expected to provide valuable data in a variety of fields. Its advantages as a high-altitude observatory are due largely to the fact that it is situated well above the bulk of the dust and moisture contained in the earth's atmosphere. At the latitude of Hawaii a "trade wind inversion layer" usually traps the dust and moisture below about 8,000 feet. Other important advantages are its ready accessibility and relatively warm climate. Most of the other comparable observatory sites are buried in snow during winter and part of the summer. Also, the Mauna Loa observatory has the required altitude without the ruggedness that imparts turbulence to the surrounding air, and it is situated at a key point for studying the huge air masses of the tropics. The chief research results to be expected are improved long-range weather forecasting and greater knowledge of solar and atmospheric radiation. Because the air masses of the Pacific are responsible for much of the weather that occurs in other parts of the world, data on these air masses may make it possible to forecast conditions in distant places.

There is some evidence that the ozone content of the lower atmosphere in the Tropics is associated with the formation of the large low-pressure areas that produce typhoons. Continuous measurement of atmospheric ozone may thus be of assistance in forecasting typhoons in advance.

The observatory also offers possibilities for study of cosmic rays, total solar radiation, snow crystals, air glows, and possibly radioactive fallout. In July, C. C. Kiess and C. H. Corliss of NBS began a study of the moisture content of the planet Mars under the auspices of the National Geographic Society. They used spectroscopic techniques to investigate the light reflected to the earth from Mars. The advantageous location of the Mauna Loa observatory made it possible to reduce the effect of the earth's atmosphere on the planet's spectrum. During the coming year Ralph Stair of NBS expects to begin a study at Mauna Loa on the distribution of the spectral energy from the sun. Such information will be of value in determining the effect of the sun's rays in connection with high-altitude equipment, space flights, and man-made satellites. This work will also furnish data on the solar constant and information on solar intensities which may be useful in many fields.

The observatory is a concrete-block structure costing $25,000, and is situated about 2,500 feet below the summit of the mountain. The building contains five rooms in addition to a tower and a broad open platform for observational use. Present accommodations permit the use of the buildings by a maximum of six observers at any one time. A smaller structure was built at the summit in 1951–52, but the limited observations that were taken there were discontinued in 1954

BOTANY.—*The genus* Hilaria (*Gramineae*).

ERNEST R. SOHNS, U. S. National Museum. (Communicated by Agnes Chase.)

(Received July 16, 1956)

Hilaria, named in honor of Auguste St. Hilaire, was described by Humboldt, Bonpland, and Kunth (1816) with one species (*H. cenchroides*) from Mexico. "Crescit in planitie montana regni Mexicana, inter Zelaya et Guanaxuato, locis subfrigidis, alt. 980 hexap. [Perennial] Floret Septembri."

According to the authors *Hilaria* resembled *Anthephora*, after which it was placed in taxonomic sequence. In the following 50 years at least three new generic names entered the literature, and all are considered synonyms of *Hilaria*. Among these is the genus *Pleuraphis*, established by Torrey (1824), with one species (*P. jamesii*) in honor of Dr. E. James. Some contemporary agrostologists recognize this genus as distinct from *Hilaria*. Presl (1830) described the genus *Hexarrhena*, with a single species (*H. cenchroides*), which he placed in the tribe Saccharinae, subtribe Hordeaceae. From his description and plate 45, there is no doubt that the species is *H. cenchroides* of Humboldt, Bonpland and Kunth. In 1866, Buckley described a new genus from Texas (*Schleropelta*) with one species *S. stolonifera*. The description applies to *H. belangeri* (*Anthephora belangeri* Steud.). By 1891, five species and two varieties of *Hilaria* had been described.

Taxonomists have differed in the assignment of the genus to tribes and subtribes. Steudel (1854) and Fournier (1886) put *Hilaria* in the tribe Phalarideae. Bentham (1881) divided the tribe Zoysieae into two subtribes (Anthephoreae and Euzoysieae) and placed the genus in the former. Bentham and Hooker (1883) and Hackel (1887) treated the genus as a member of the Zoysieae. Beal (1896), Bews (1929), Conzatti (1946), Hitchcock (1936) and Roshevits (1937) regarded this genus as belonging to the Zoysieae. Pilger (1954) placed *Hilaria* in the subfamily Eragrostoideae, subtribe Lappagineae Link. He also recognized *Pleuraphis* as a distinct genus.

I believe the genus is a very old and highly specialized one and that it does not belong in the tribe Zoysieae. It has no close generic relationship with any known North or South American genus. Cytogenetic techniques may help indicate evolutionary tendencies within the genus. For the present it is better to keep the genus in the Zoysieae than to erect a new tribe or subtribe. The accumulation of cytogenetic data, together with detailed taxonomic, morphological and anatomical studies in our known genera will enable us, eventually, to assign the genus *Hilaria* to its proper tribe.

The species of *Hilaria* are vegetatively remarkably uniform for both subgenera of the genus. They are mostly low, stoloniferous or nonstoloniferous plants with pistillate central spikelets or tall, rhizomatous bunch grasses with perfect central spikelets. The nine species and one variety at present known are endemics restricted to the mountains, dry plains and plateaus of the southwestern United States, Mexico and Guatemala. One species, *H. belangeri*, has been reported from Venezuela (cultivated in experiment plots). The inflorescence is spicate and composed of two to many fascicles. Each fascicle contains three spikelets, one central and two lateral spikelets. The central spikelet is 1-flowered and perfect in *H. jamesii*, *H. mutica* and *H. rigida*. One-flowered, pistillate central spikelets are characteristic of the other species. The lateral spikelets, appearing somewhat pedicellate, are all staminate and may have from one to five florets. Any one, or all of the lateral florets, may be sterile. The glumes in those species with perfect central spikelets may be papyraceous and scarcely fused at the base, or, in those species with pistillate central spikelets, the glumes are rigid, indurated and fused at the base. The fascicle pattern is the same for all species of the genus. Diagrammatic sketches of various fascicle patterns are presented in fig. 1.

Brown (1950) and Brown and Coe (1951) have been the pioneers in cytogenetic investigations in this genus. *H. belangeri* (collection no. 3394) was reported to have a

chromosome number of 36, and *H. mutica* (collection no. 3279) a diploid number of 36 (n = 18). *H. belangeri* (Ozona Clone) has 36 chromosomes (n = 9), while *H. belangeri* (Eden no. 4 and Eden no. 6) has 72 chromosomes (n = 9). The phenomenon of ovule abortion in *H. belangeri*, *H. jamesii* and *H. mutica* is discussed also.

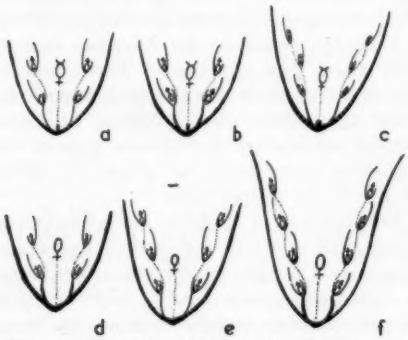


FIG. 1.—Fascicle diagrams in *Hilaria: a–c*, Fascicle types encountered in the subgenus Pleurapheae: central spikelets 1-flowered and perfect, lateral spikelets 2–3-flowered, all staminate or the lower sometimes sterile. *d–f*, fascicle types encountered in the subgenus Eu-Hilarieae: central spikelets 1-flowered and pistillate, lateral spikelets 1–5-flowered, all staminate or staminate and sterile intermixed. Only one glume of each lateral spikelet is represented.

The species of *Hilaria* are among the important forage grasses of the ranges in the southwestern United States and Mexico. The rapid spread of the stoloniferous species also makes them important soil binders. In the genus *Hilaria*, *H. belangeri* is probably the most important range species. *H. jamesii* and *H. mutica* are regarded as having medium grazing value and low to very low palatability. *Hilaria jamesii* is often the dominant grass in many parts of northern Arizona and New Mexico and in southern Colorado and Utah. When this species is young it is good forage for sheep. *H. mutica* is characteristic of level upland and desert valleys in which there are no really permanent streams, but these areas are occasionally overflowed during heavy storms. According to Goodding (mss.) the inflorescences are often infected with ergot. *Hilaria rigida* occupies the driest parts of the desert areas, particularly the Mojave Desert. It is encountered on sand dunes and rocky slopes. This species forms isolated clumps and is therefore an excellent grass for controlling blowing sand. It is a highly prized grass in southern Nevada and in the region of Kingman, Arizona.

This paper is part of a continuing series contributing toward a revision of the Grasses of Mexico; therefore, only Mexican specimens are cited, except where the type was collected in the United States. All figures, unless otherwise indicated, were drawn by the author.

KEY TO SPECIES OF HILARIA

A. Fascicles with thin, papyraceous glumes, these not conspicuously fused and indurated at the base; the central spikelet 1-flowered and perfect [subgenus Pleurapheae].
  B. Culms felty-pubescent; glumes of the central spikelet narrow, plumose, deeply cleft into few to several acuminate, ciliate lobes and slender awns; glumes of the lateral spikelets thin, long-ciliate, 2–4-lobed at the summit ..... 3. *H. rigida*
  BB. Culms not felty-pubescent.
    C. Glumes of the lateral spikelets acute, usually with a single awn ..... 1. *H. jamesii*
    CC. Glumes of the lateral spikelets thin, broadened upwards, the tips finely laciniate ..... 2. *H. mutica*
AA. Fascicle with thickened asymmetric glumes, conspicuously fused and indurated at the base; the central spikelets 1-flowered and pistillate [subgenus Eu-Hilarieae].
    D. Spikes pale and usually slender (if thick, then the glumes papillose-pilose between the nerves); sometimes violaceous from the accumulation of anthocyanin pigmentation; scabrous black glands may be present, but usually not abundant.
      E. Plants stoloniferous, blades mostly basal.
        F. Glumes scabrous; awns short, slightly divergent, thick, conspicuously ciliate on the margins, the cilia often retrorse ..... 6. *H. ciliata*
        FF. Glumes variously textured; awns not ciliate on the margins.
          G. Fascicles 5–6 mm long.
            H. Glumes usually with one, rarely more, awns, margins conspicuously hyaline; plants wiry, densely tufted ..... 4. *H. belangeri*
            HH. First glume of the central spikelet thick, terminating

in 2–5 awns, margins not hyaline; glumes of the central spikelet thick, terminating in 2–4 awns; plants not wiry or densely tufted
7. *H. hintonii*

GG. Fascicles 8–10 mm long; glumes conspicuously papillose-pilose between the nerves, the lemmas sparingly pilose on the back toward the tip
8. *H. semplei*

EE. Plants apparently non-stoloniferous; blades long, flat; ligule 2.5–3 mm long; spikes scarcely exceeding the blades
4a. *H. belangeri* var. *longifolia*

DD. Spikes mostly gray to black; coloration resulting either from numerous scabrous black glands or the accumulation of anthocyanin pigmentation, or both.

I. Spikes slender; fascicles 6.5–8 mm long; glumes narrow at the base, as long as the florets, dark gray to almost black, the margins hyaline and conspicuously lighter in color; lateral spikelets 2-flowered
9. *H. swallenii*

II. Spikes usually thick; fascicles 4–7.5 mm long; glumes broader at the base, shorter than the florets, the margins not conspicuously lighter in color nor hyaline; lateral spikelets 2–4-flowered (rarely 5-flowered)....5. *H. cenchroides*

1. **Hilaria jamesii** (Torr.) Benth., Journ. Linn. Soc., Bot. **19:** 62. 1881.
Pleuraphis jamesii Torr., Ann. Lyc. New York **1:** 148. *pl. 10.* 1824.

Perennial, tufted, rhizomatous; culms erect, 20–65 cm tall, nodes pubescent; sheaths glabrous or slightly scabrous, sparsely villous near the collar and behind the ligule; ligule 2–3 mm long, membranaceous, often laciniate; blades 2–20 cm long, 2–4 mm wide, involute when dry, scaberulous on the lower surface, scabrous on the upper between the nerves; spike thick, 2–6 cm long, rachis joints up to 6 mm long, angular, finely pubescent; fascicles 6–8 mm long, long-villous at the base; lateral spikelets 3-flowered, staminate; stamens 3, anthers of the first floret about 5 mm long; lodicules 2, 0.1–0.2 mm long; central spikelet 1-flowered, perfect; lodicules 2, about 0.2 mm long.

Distribution: Arizona, California, Colorado, Nevada, Texas, Utah, and Wyoming.

2. **Hilaria mutica** (Buckl.) Benth., Journ. Linn. Soc., Bot. **19:** 62. 1881.
Pleuraphis mutica Buckl., Proc. Acad. Nat. Sci. Philadelphia 1862: 95. 1862.

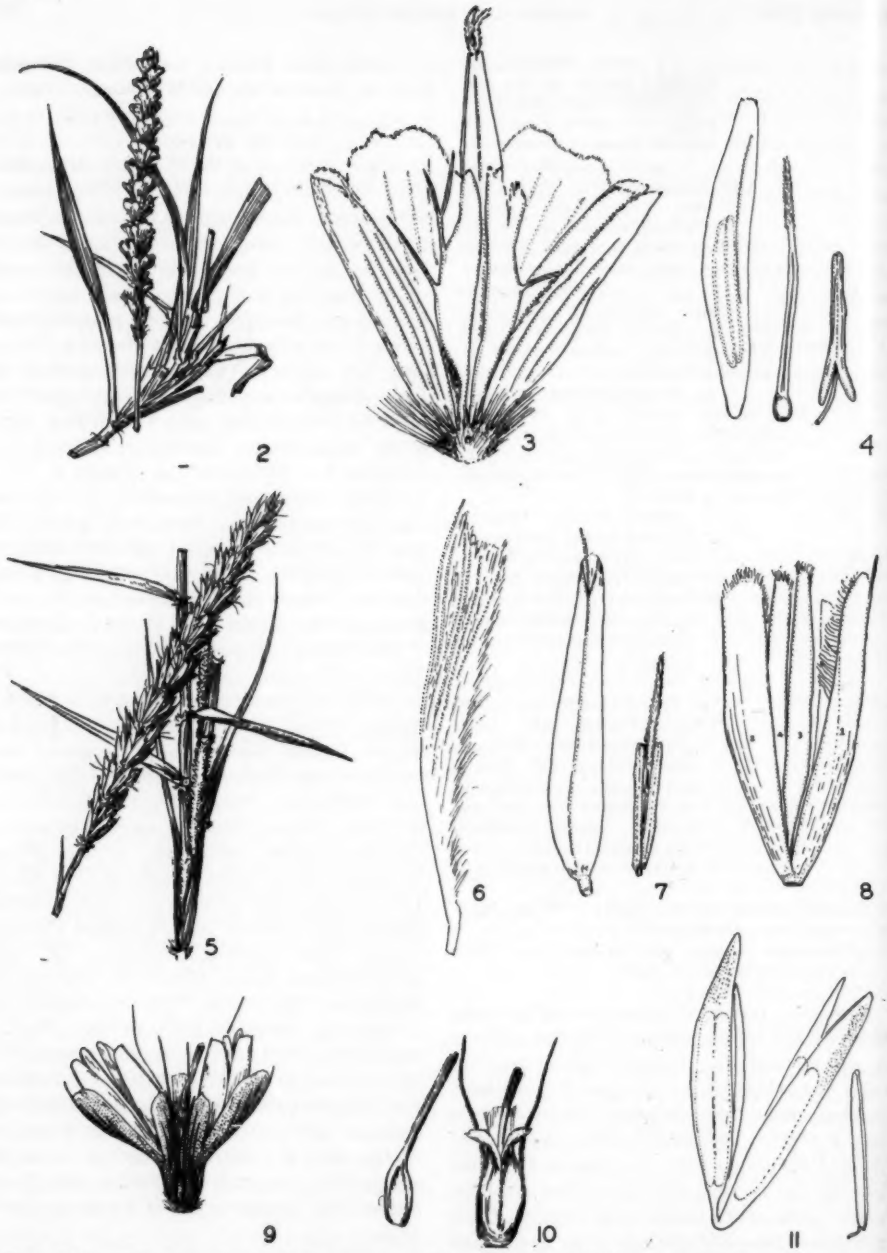
Perennial, tufted, rhizomatous; culms erect, 30–50 cm tall, nodes pubescent; sheaths striate, firm, scabrid, the lower overlapping the upper, shorter than the nodes, scabrous and sometimes sparsely papillose-pilose along the margins; ligule about 1 mm long, lacerate; blades up to 10 cm long, 2–4 mm wide, harshly short-scabrous on both surfaces, sometimes sparsely papillose-pilose on both surfaces; spike 4–8 cm long, joints of the spike slender, fascicles crowded; lateral spikelets 1 or 2-flowered (sometimes 3- or 4-flowered), staminate; lodicules 2, 0.1–0.2 mm long; glumes thin and broadened upward, the tips finely laciniate; central spikelet 1-flowered, perfect; lodicules 2, 0.1–0.2 mm long; glumes with one or more divergent awns from the back, the tips of the glumes lobed and finely laciniate.

Distribution: Arizona, Oklahoma, New Mexico, Texas, and northern Mexico.

MEXICO: CHIHUAHUA: 10 km E. of Jiménez, *Harvey* 1348; Rancho Carretas, Chihuahua-Sonora Border, *Harvey* 1534; Meoqui, *LeSeur* 040; south of Chihuahua, *LeSeur* 0132; plains near Chihuahua, *Pringle* 485; 19 mi. northwest of Naica, *Shreve* 8080; 31 miles northeast of Camargo, *Shreve* 8895; Sta. Eulalia Plains, *Wilkinson* 55. COAHUILA: Road to Don Martin Dam, *Harvey* 926; El Berrendo, near Múzquiz, *Harvey* 1175; 100 km west of Cuatro Ciénegas, *Harvey* 1254; *Johnson*, September 12, 1906; Músquiz-Santa Anna, *Marsh* 497; Del Carmen Mountains, *Marsh* 853; Torreon, *Palmer* 506; ... between Hacienda La Rosa and Hacienda Lechuguilla, *Wynd and Mueller* 61; eastern slope of the Sierra de San Manuel, *Wynd and Mueller* 481. DURANGO: 3 miles northeast of Bermejillo, *Johnston* 7788; 49 miles north of Bermejillo, *Morley* 618; 3 miles Northeast of Bermejillo, *Shreve* 8816. SONORA: 3 miles east of Agua Prieta, *Santos* 1751; 5 miles north of Fronteras, *Santos* 1775.

3. **Hilaria rigida** (Thurb.) Bentham, ex Scribn., Bull. Torrey Bot. Club **9:** 86. 1882.
Pleuraphis rigida Thurber, in S. Wats., Bot. California **2:** 293.8 180.

Perennial; culms decumbent or rhizomatous



FIGS. 2–11.—*Hilaria mutica:* 2, Inflorescence and base of plant, ×1 (drawn by M. W. Gill from Toumey specimen); 3, spikelet (Wright 760–2108, type); 4, floret of central spikelet, ovary and stamen (Le Seur 0132). *Hilaria rigida:* 5, Inflorescence and vegetative portion of plant, ×1 (drawn by M. W. Gill from Palmer (no. 494) specimen); 6, glume of central spikelet (Cooper 2230, type); 7, floret of central spikelet and essential organs (Cooper 2230, type); 8, florets of lateral spikelets (Keck 4232). *Hilaria belangeri:* 9, fascicle; 10, central spikelet and floret (both drawn by A. Chase from Hitchcock specimen); 11, florets of lateral spikelet and one stamen (Nealley 600). All figures, unless otherwise indicated, ×8.

at base, up to 2.5 m tall, woody felty-pubescent, upper nodes often pubescent; sheaths overlapping, glabrous or scabrous, a woolly line across the back at the collar; ligule about 1 mm long, woolly; blades 2–5 cm long or longer, 2–4 mm wide, slightly involute, glabrous or scabrous on the nerves on both surfaces, lower sheaths and blades sometimes tomentose-pubescent; spike 4–7 cm long, fascicles 6–12 mm long, densely bearded at the base; lateral spikelets 2 to 4-flowered, staminate (if 3 or 4-flowered, uppermost usually sterile); lodicules 2, 0.1–0.2 mm long; glumes of the lateral spikelets thin, long-ciliate, about 7-nerved, usually 2–4-lobed at the broad summit and with 1–3 nerves excurrent into slender awns, nerves sometimes obscure and scarcely excurrent (variable in the same inflorescence); central spikelet 1-flowered, perfect, distinctly pedicellate, equaling or exceeding the lateral spikelets, its narrow glumes deeply cleft into few to several acuminate ciliate lobes and slender awns; lemma often exceeding the glumes, thin, ciliate, 2-lobed, the midnerve excurrent as a short awn; stamens 3, anthers 4–4.5 mm long; stigmas 2, plumose, terminally exserted; lodicules 2, 0.1 mm long.

According to Watson (1880) this species was eaten avidly by pack animals.

Distribution: Arizona, California, Nevada, Utah, Lower California, and Sonora.

UNITED STATES: CALIFORNIA: Fort Mojave, *Cooper* 2230 (Type).

MEXICO: BAJA CALIFORNIA: Canon Cantillas, *Orcutt* 1145. CHIHUAHUA: Colonia Diaz, *Mearns* 406. SONORA: 50 miles south of Sonoyta on road to San Luis, *Keck* 4232.

4. **Hilaria belangeri** (Steud.) Nash, N. Amer. Fl. **17:** 135. 1912.
Anthephora belangeri Steud., Syn. Pl. Glum. **1:** 111. 1854.

Perennial, tufted, stoloniferous; culms 10 to 30 cm tall, erect, nodes villous; sheaths striate, glabrous, overlapping, upper sheaths shorter than the internodes; ligule 1.5 mm long, membranaceous; blades 3 to 10 cm long, flat or involute when dry, sparsely papillose-pilose on the margins and on the upper surface, tip involute; spike 2–4 cm long, fascicles 5–6 mm long; glumes firm, united below, scabrous, usually pale or sometimes violaceous, but not dark gray or black from glandular spots, rounded or pointed upwards, terminating in one or more antrorsely scabrous awns as long as or longer than the fascicle; lateral spikelets 2-flowered (rarely 3-flowered), staminate or sometimes one floret neuter; stamens 3, anthers of the lower floret 3–3.5 mm long; anthers of the upper floret 3.2–3.7 mm long; central spikelet 1-flowered, pistillate, as long or longer than the lateral spikelet.

Distribution: Arizona, California, New Mexico, Texas, and Mexico.

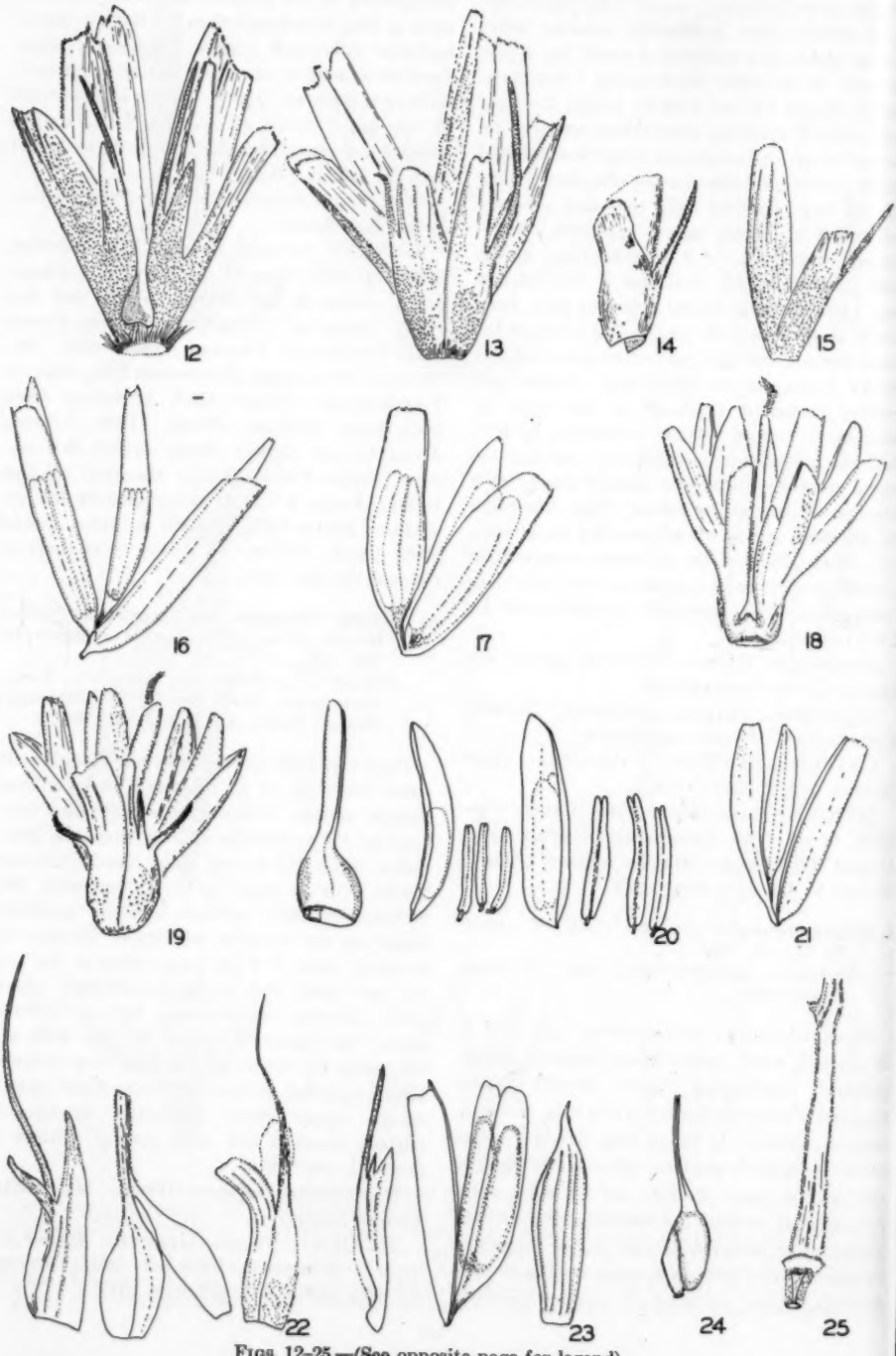
MEXICO: AGUASCALIENTES: Aguascalientes, *Hitchcock* 7477. BAJA CALIFORNIA: La Champagna, Sierra de las Palmas, *Gentry* and *Fox* 11787. CHIHUAHUA: Rancho Carretos, *Harvey* 1621. GUERRERO: Coyuca, *Hinton* 6707. MICHOACÁN: Apatzingan, *Leavenworth* 1521. MÉXICO Temascaltepec, *Hinton* 4733. MORELOS: Lava fields near Yautepec, *Pringle* 11225; between Xoxocotla and Alpuyec, *Sharp* 441358. SONORA: near Imuris, *Pennell* 20278; Hacienda de San Rafael, *Santos* 1782; 20 miles west of La Angostura, *Santos* 1802; Colonia Morelos, *Santos* 2032 [Sept. 15–Oct. 4, 1941]. TAMAULIPAS: Chamal, *Swallen* 1680, 1698.

4a. **Hilaria belangeri** var. **longifolia** (Vasey) Hitchc., Proc. Biol. Soc. Washington **41:** 162. 1928.
Hilaria cenchroides var. *longifolia* Vasey, Proc. Amer. Acad. Sci. **24:** 80. 1889; Beal, Grasses North America **2:** 69. 1896.

Perennial, tufted, apparently non-stoloniferous; culms erect, 30 cm or more tall, nodes villous; sheaths striate, scabrous, basal sheaths overlapping, upper sheaths shorter than the internodes; ligule 2.5–3 mm long, membranaceous; blades 3–15 cm long, up to 3.5 mm wide, flat, scabrous on both surfaces, sparsely papillose-pilose on the margins and upper surface, tip involute; spike 2–4 cm long, joints of the axis 3–5 mm long, flat, margins antrorsely short-pilose; fascicles 5–8 mm long, 5–12 per inflorescence; first glume of lateral spikelet with one long awn, the others half as long, free or fused; lateral spikelets 2-flowered, lower floret usually neuter, upper floret staminate; stamens 3, anthers about 3 mm long; central spikelet 1-flowered, pistillate.

Distribution: Arizona, Texas, and northwestern Mexico.

MEXICO: SONORA: Guaymas, *Palmer* 347 (type); Guaymas, *Hitchcock* 3558; Colonia Morelos, *Santos* 2032 [15 Sept. 1947].



FIGS. 12–25.—(See opposite page for legend).

5. **Hilaria cenchroides** H. B. K., Nov. Gen. & Sp. **1**: 117. *pl. 37*. 1816.

Perennial, tufted, stoloniferous; culms erect, 5–60 cm tall, nodes pilose; sheaths striate, overlapping, margins hyaline, the lower from sparsely to densely papillose-pilose, the upper glabrous and shorter than the internodes; ligule 1.5–2 mm long, laciniate; blades up to 10 cm long, to 4 mm wide, flat, involute on drying, slightly scabrous on the lower surface, very scabrous on the upper surface, sometimes also sparsely papillose-pilose, margins antrorsely scabrous; spikes 2–6 cm long, dark brown to purple in color; rachis joints scabrous-pubescent on the margins; fascicles 4–7.5 mm long; glumes usually shorter than the spikes, indurated and fused at the base; lateral spikelets 2–4-flowered (rarely 5 florets), staminate or some of them sterile; stamens 3, anthers 3–3.5 mm long, yellow; central spikelet 1-flowered, pistillate.

Distribution: Mexico to Guatemala.

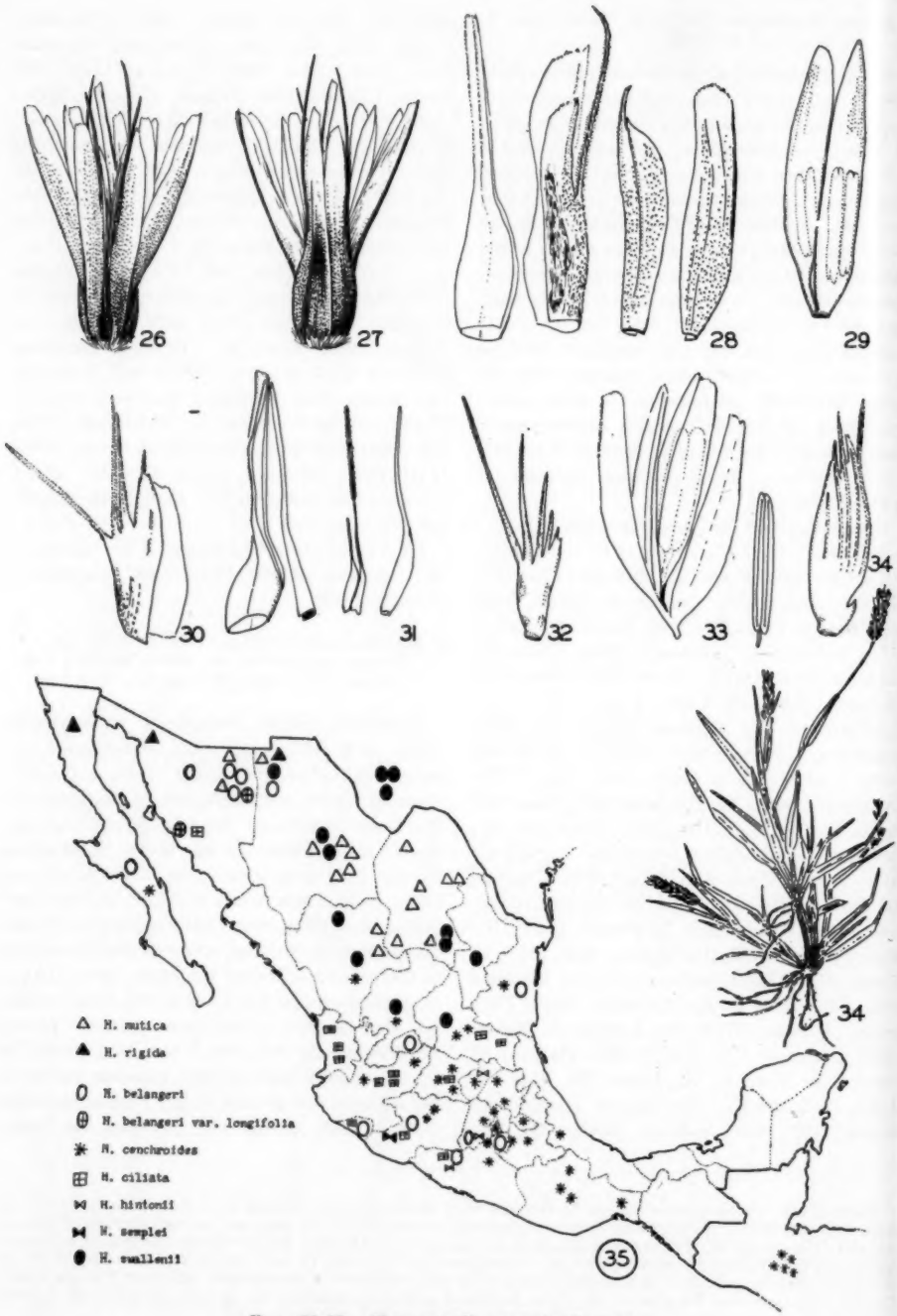
MEXICO: BAJA CALIFORNIA: 19 miles northeast of Comondu, *Shreve* 7120. DISTRITO FEDERAL: Mixcoac, *Arsène* 8281; Camino de Toluca, *Balls* 5587; Mexico City, *Fisher* 70; San Ángel, *Fisher* 113; Xochimilco, *Hitchcock* 5889; Pedregal, *Hitchcock* 5950; Olivar, *Orcutt* 3591. DURANGO: Durango, *Hitchcock* 7580; *Palmer* 379, 541. GUANAJUATO: The Alameda, *Dugis*, July 1899; Acámbaro, *Hitchcock* 6939; Irapuato, *Hitchcock* 7430; 6 kms east of Guanajuato, *Sohns* 318. GUERRERO: Santa Fé, *Hitchcock* 6687. HIDALGO: Jacala, *V. H. Chase* 7110, 7230; Pachuca, *Hitchcock* 6718 ½; Guadalupe, *Juzepczuk* 114; Puerto de la Zorra, *Moore* and *Wood* 3776. JALISCO: La Punta, *Hitchcock* 7000; San Nicolás, *Hitchcock* 7188; Guadalajara, *Hitchcock* 7268; Río Blanco, *Palmer* 197; Huejuquilla, *Rose* 2542; La Punta, *Shreve* 9289. MÉXICO: Toluca, *Hitchcock* 6905; Molino de la Flor, *Matuda* 18932; Zumpango, *Matuda* 19723; San Gerónimo, *Matuda* 29247; Atizapan, *St. Pierre* 205; Tlalpan, *St. Pierre* 818; Mixcoac, *St. Pierre* 833, 881; San Ángel, *St. Pierre* 851; San Juan de Teotihuacan, *Santos* 2197; San Andreas, *Sohns* 190. MICHOACÁN: Morelia, *Arsène* 5587; Zitácuaro, *Hinton* 13113. MORELOS: Cuernavaca, *Hitchcock* 6861; *Ross*, June 1953. OAXACA: Cerro del Fortin, *Conzatti* 3588; Oaxaca, *Hitchcock* 6096; Valle de Oaxaca, *Liebmann* 571; Tehuantepec, *Matuda* 311; Valle de Oaxaca, *Nelson* 1576; Valley of Cuicatlan, *Nelson* 1906; El Cerro de San Felipe del Agua, *Santos* 3208. PUEBLA: Fort de Loreto, *Arsène* 35; vicinity of Puebla, *Arsène* 284, 1019; Atlixco, *Nelson* 25/7/1893; San Francisco, *Nicolas* 15/8/1909; Cholula, *Nicolas* 14/7/1909. QUERÉTARO: Querétaro, *Arsène* 10274, Querétaro, *Hitchcock* 5865, 5870; *Semple*, November 1955. SAN LUIS POTOSÍ: Cardenas, *Hitchcock* 5713; Alvarez, *Palmer* 165. TAMAULIPAS: Buena Vista Hacienda, *Wooton* 21/6/1919. TLAXCALA: San Cristóbal to Calpulalpan, *Sohns* 573. VERACRUZ: Santa Ana Chiautempan, *Arsène* 11/10/1908; Orizaba, *Hitchcock* 6353; *Mohr; Mueller* 2079; *Schaffner* 199. ZACATECAS: Zacatecas, *Hitchcock* 7537.

GUATEMALA: Guatemala City, *Hitchcock* 9084; *de Koninck* 142; *Popenoe* 667; La Aurora, *Morales R.* 726.

6. **Hilaria ciliata** (Scribn.) Sohns, comb. nov.
Hilaria cenchroides var. *ciliata* Scribn., Proc. Acad. Nat. Sci. Philadelphia 1891: 293.

Perennial, tufted, sometimes stoloniferous; culms up to 45 cm tall, erect, sometimes finely pubescent below the lower nodes, otherwise glabrous; nodes pilose; sheaths striate, glabrous, the lower sometimes sparsely papillose-pilose, usually shorter than the internodes; ligule about 2.5 mm long, membranaceous; blades 1.5–15 cm long, up to 4 mm wide, scabrous on both surfaces and margins, occasionally sparsely papillose-pilose on both surfaces, sparsely papillose-pilose at the collar and behind the ligule; spike 3–5 cm long, joints of axis 2.5–3.5 mm long, finely ciliate on the margins, sometimes sparsely pilose; fascicles mostly less than 4 mm long (rarely to 5 mm); glumes fused at base, papillate-scabrous; the awns of the glumes of the central spikelets 1 or 2, these usually not exceeding the lobes,

FIGS. 12–25.—*Hilaria cenchroides:* 12, Abaxial view of fascicle; 13, adaxial view of fascicle (both drawn from Galeotti 5689); 14, glume of central spikelet (Hinton 13113); 15, first and second glumes of lateral spikelet (Hinton 13113); 16, three florets from lateral spikelet (Hinton 13113); 17, two florets from lateral spikelet (Palmer 379). *Hilaria ciliata:* 18, Abaxial view of fascicle; 19, adaxial view of fascicle; 20, floret of central spikelet and first and second florets of lateral spikelets with stamens (all from Pringle 3128). *Hilaria belangeri* var. *longifolia:* 21, three florets of a lateral spikelet; 22, central spikelet; 23, lateral spikelet; 24, caryopsis; 25, rachis joint. All from Palmer 347. All figures ×8.



FIGS. 26–35.—(See opposite page for legend).

sometimes reflexed at maturity, short-ciliate on the margins, the cilia often retrorse; awns of the lateral spikelets inconspicuous; lateral spikelets 2-flowered, staminate; stamens 3, anthers of the upper floret 2.8–3 mm long; central spikelet 1-flowered, pistillate.

Distribution: Known only from Mexico.

MEXICO: COLIMA: Alzada, *Hitchcock* 7077; Armeria, *Hitchcock* 7022; Manzanillo, *Hitchcock* 833; *Palmer* 197, 1267. GUERRERO: Mina, *Hinton* 9310. JALISCO: Zapotlán, *Hitchcock* 7125; Guadalajara, *Hitchcock* 7370; Valley of the Rio Grande de Santiago at Atequiza, *Palmer* 3128 (Type). MICHOACÁN: Aguililla, *Hinton* 12093, 15213; Apatzingan, *Hinton* 12029; *Leavenworth* 1521, 1590; near Nueva Italia, *Sohns* 847. NAYARIT: Vicinity of Jalisco, *Ferris* 5818; Tepic, *Palmer* 1918; Acaponeta, *Rose, Standley and Russell* 14304. SAN LUIS POTOSÍ: Valley of the Río Tampaon, *V. H. Chase* 7530; Cardenas, *Hitchcock* 5774. SONORA: Palmer, s. n.

7. **Hilaria hintonii** Sohns, sp. nov.

Gramen perenne, stoloniferum; culmi 5–20 cm alti, nodi pubescenti; vaginae glabrae vel leviter pilosae; ligula 0.5–1 mm longa, membranacea; laminae 2–6 cm longae, usque ad 4 mm latae, planae, supra papilloso-pilosae, subtus glabrae vel interdum leviter papilloso-pilosae, margines scabrae; spicae 2–4 longae, articuli rachi plani, 1–4.5 mm longi; fasciculi 4–6.5 mm longi, glumae induratae, scaberulae; spiculae laterales bi- vel triflores, masculae; spicula intermedia uniflora, feminea.

Perennial, tufted, stoloniferous; culms 5–20 cm tall, erect; nodes pubescent; sheaths glabrous or sparingly pilose near the collar; ligule 0.5–1 mm long, membranaceous; blades 2–6 cm long, up to 4 mm wide, flat, thin, papillose-pilose on the upper surface, scabrous on the lower or sometimes sparsely papillose-pilose, margins scabrous, the tip acuminate; spikes 2–4 cm long, joints of the axis flat, 1–4.5 mm long, margins short ciliate; fascicles 4–6.5 mm long, the glumes indurated and fused at the base, scaberulous to sparsely glandular-spotted; first glumes of the lateral spikelets indurated at the base, the tips terminating in 3 or 4 awns, one of which is as long as the spikelets; second glumes of the lateral spikelets broad, indurated, terminating in 2 to 4 awns of approximately equal length; lateral spikelets 2–3-flowered, staminate, or the lower sometimes sterile, stamens 3, anthers 2.8–3 mm long; glumes of the central spikelet with more or less truncated tips and 2 or 3 prominent awns; central spikelet 1-flowered, pistillate.

This species is named in honor of the late Mr. G. B. Hinton, exceptional collector of Mexican grasses.

TYPE: Temascaltepec, Mexico; Luvianos, llano, 9/8/1933; *Hinton* 4502 (U.S.N.H. no. 1840874).

Distribution: Central Mexico.

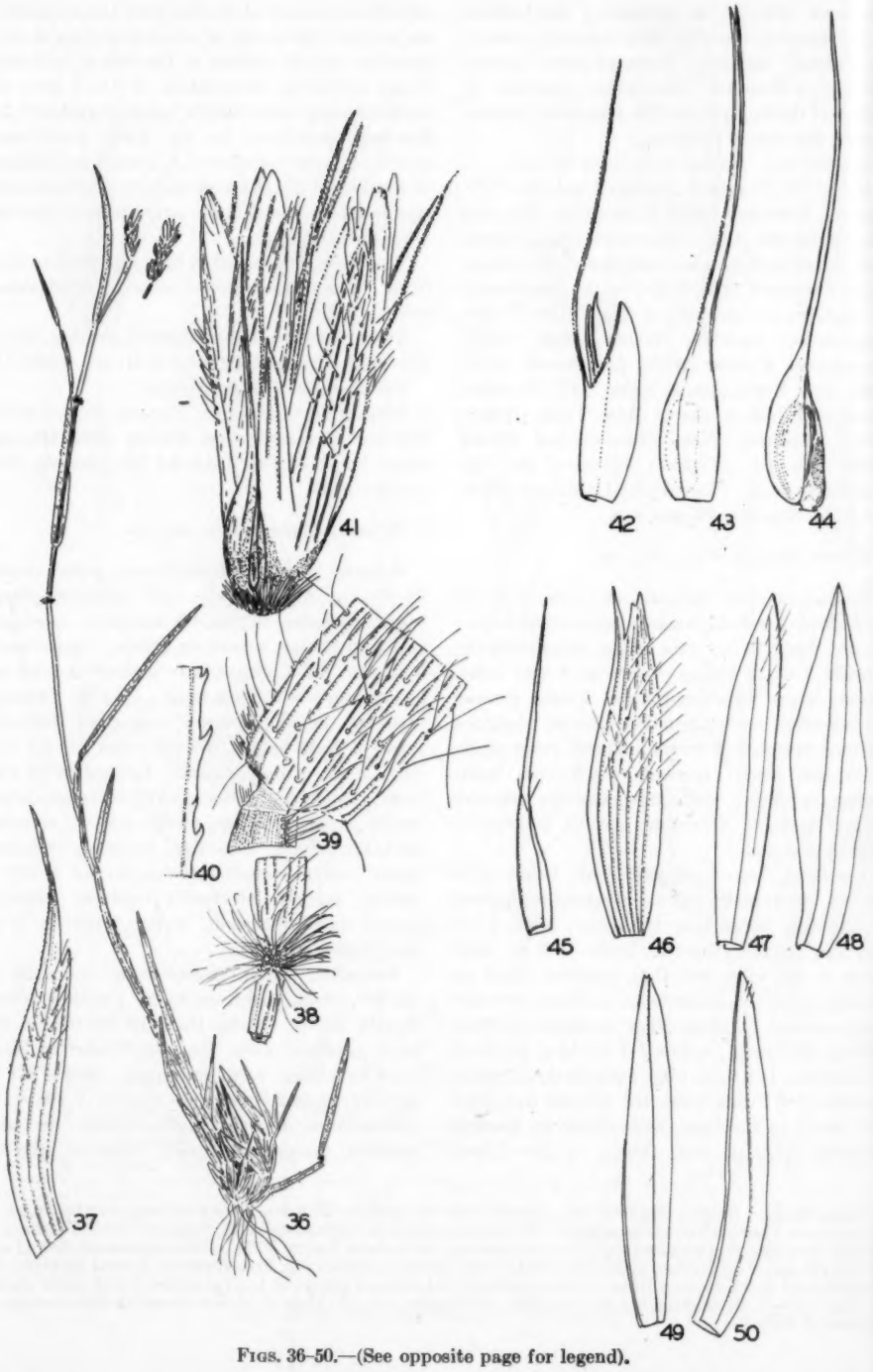
MEXICO: GUERRERO: Coyuca, *Hinton* 6437. MÉXICO: Temascaltepec, *Hinton* 4502. QUERÉTARO: South of San Juan del Río, *Semple*, November 1955.

8. **Hilaria semplei** Sohns, sp. nov.

Gramen perenne, stoloniferum; culmi erecti, 20–35 cm alti, glabri; nodi papilloso-pilosi; vaginae striatae, internodiis breviores, inferiores papilloso-pilosae, superiores glabrae; ligula membranacea, 0.5–1 mm longa; laminae 2.5–15 cm longae, usque ad 2.5 mm latae, plana vel V-forma, utrinque papilloso-pilosae, margines scabrae; spicae 2–4 cm longae, articuli rachi 2.5–4.5 mm longi, plani, margines ciliati; fasciculi 8–10 mm longi; glumae induratae, valde nervosae, internerviis papilloso-pilosae, aristae scabrae; spiculae laterales biflores, masculae; lemmata membranacea, summa tenuiter pilosi, leviter 3 vel 4-nerviis; spicula intermedia uniflora, feminea; lemma membranaceum, leviter 3-nerviis, 8–10 mm longum.

Perennial, tufted, stoloniferous; culms 20–35 cm tall, erect, glabrous; nodes papillose-pilose; sheaths striate, shorter than the internodes, the lower papillose-pilose, the upper glabrous; ligule 0.5–1 mm long, membranaceous; blades 2.5–15 cm long, up to 2.5 mm wide, slightly V-shaped in cross-section or flat, papillose-pilose on both surfaces, margins antrorsely scabrous, the tip

FIGS. 26–35.—*Hilaria swallenii:* 26, Abaxial view of fascicle; 27, adaxial view of fascicle (drawn by A. Chase from Young (No. 46) specimen); 28, lemma, glume of central spikelet, first and second glumes of lateral spikelet; 29, two florets of a lateral spikelet (both from Sperry T778). *Hilaria hintonii:* 30, glume of central spikelet; 31, two pistillate florets from central spikelet; 32, first glume of lateral spikelet; 33, three florets and a stamen from a lateral spikelet; 34, second glume of lateral spikelet and habit sketch of plant (×½). All drawn from Hinton 4502. All figures ×8. 35: Map of Mexico showing distribution of species of *Hilaria*.



FIGS. 36–50.—(See opposite page for legend).

involute; spike 2–4 cm long, joints of the axis 2.5–4.5 mm long, flat, the margins finely ciliate, rachis flaps prominent, tips finely ciliate; fascicles 8–10 mm long; glumes fused at base, strongly nerved, papillose-pilose between the nerves, awns prominent, antrorsely scabrous; lateral spikelets 2-flowered, the florets staminate, lemmas membranaceous, faintly 3- or 4-nerved, the tips sparingly pilose, paleas membranaceous, as long as the lemmas, 2-nerved; central spikelet 1-flowered, pistillate; lemma membranaceous, faintly 3-nerved, 8–10 mm long.

This species is named in honor of Dr. A. T. Semple, Food and Agricultural Organization of the United Nations.

TYPE: Dense heavy stands on very heavy clay soil; dominant grass over many areas; Llanos de Antuñez, about 12 miles east of Apatzingan, Michoacán, alt. 1,000 feet; November 1955, *A. T. Semple* (U.S.N.H. no. 2183565). Dry grasslands between Nueva Italia and Apatzingan, alt. 430 m., dominant grass; November 14, 1955; *Moore, Hernández X.* and *Porras H.* 5753.

9. **Hilaria swallenii** Cory, Wrightia **1:** 215. 1948.

Perennial, tufted, stoloniferous; culms erect, 10 to 30 cm tall, nodes villous; sheaths shorter than the internodes, slightly scabrous; ligule 2–2.2 mm long, membranaceous; blades mostly short, basal, up to 8 cm long, 1–2 mm wide, flat or involute when dry, scabrous on both surfaces; spike 1–4 cm long, gray to dark-brown in color, sparsely to densely provided with glands; rachis joints 4–6 mm long, sparsely short-scabrous on the margins and over the back; fascicles 6.5–8 mm long, 2 to 8 per spike, narrow, appressed, not conspicuously flabellate at maturity; glumes connate at base, margins usually hyaline and light gray to whitish; lateral spikelets 2-flowered, the lower floret usually sterile, the upper staminate, stamens 3, anthers 3–3.5 mm long; central spikelet 1-flowered, pistillate, the base of the lemma usually elliptic.

Distribution: Davis Mountains area of Texas and Mexico.

UNITED STATES: TEXAS: Músquiz Canyon, *Sperry* T778 (Type).

MEXICO: CHIHUAHUA: 19 km North of Río San Pedro on Parral-Chihuahua Road, *Harvey* 1432; 2 km west of Carretas, *Harvey* 1568; near Chihuahua, *Pringle* 493. COAHUILA: 3 miles southeast of Saltillo, *Johnston* 7251; 2 miles southeast of Saltillo, *Shreve* 8509. DURANGO: 5½ miles south of Ignacio Allende, *Gentry* 6915; near Torreón de las Canas, *Gentry* 8639. NUEVO LÉON: Galena, *V. H. Chase* 7763. SAN LUIS POTOSÍ: Charcas, *Lundell* 5515; Charcas, *Whiting* 508, 528. ZACATEAS: Among cerros 6 miles southeast of Carboneras, *Gentry* 8504.

LITERATURE CITED

BEAL, W. J. *Grasses of North America* **2:** 65. 1896.

BENTHAM, G. *Notes on Gramineae*. Journ. Linn. Soc. Bot. **19:** 61–63. 1881.

BENTHAM, G., and HOOKER, J. D. *Genera plantarum* **3:** 1121. 1883.

BEWS, J. W. *The world's grasses:* 69, 121, 214. London, 1929.

BROWN, W. V. *A cytological study of some Texas Gramineae*. Bull. Torrey Bot. Club **77:** 63–76. 1950.

BROWN, W. V. and COE, G. E. *A study of sterility in* Hilaria belangeri (*Steud.*) *Nash* and Hilaria mutica (*Buckl.*) *Benth.* Amer. Journ. Bot. **38:** 823–830. 1951.

BUCKLEY, S. B. *Description of new Texas grasses* —Schleropelta *n. genus*. Prel. Rep. Geol. & Agr. Surv. Texas. App. 1: 1. 1866.

CONZATTI, C. *Flora taxonomica Mexicana* **1:** 172, 176–177. 1946.

FOURNIER, E. *Mexicanas plantas. Pars secunda:* 70, 72–73. Paris, 1886.

HACKEL, E. *Gramineae (echte Gräser)*. Die natürlichlen Pflanzenfamilien **2²:** 30. 1887.

HITCHCOCK, A. S. *The genera of the grasses of the United States*. U. S. Dept. Agr. Techn. Bull. 772: 172–174. 1936.

HUMBOLDT, A., BONPLAND, A., and KUNTH, C. S. *Nova genera et species plantarum* **1:** 116–118. *pl. 37.* 1815.

PILGER, R. *Das System der Gramineae*. Bot. Jahrb. **76:** 348. 1954.

PRESL, J. S. *Reliquiae Haenkeanae* **1:** 326. *pl. 45.* Prague, 1830.

ROSHEVITS, R. YU. *Grasses:* 168, 522, 530. Moscow, 1937.

STEUDEL, E. G. *Synopsis plantarum glumacearum*, pt. 1: 12. 1854.

TORREY, JOHN. *Description of some new grasses collected by Dr. E. James, in the expedition of Major Long to the Rocky Mountains, in 1819–1820*. Ann. Lyc. New York **1:** 148–150. *pl. 10.* 1824.

FIGS. 36–50.—*Hilaria semplei* Sohns, sp. nov.: 36, Habit sketch of plant, ×½; 37, basal sheath and blade; 38, node; 39, junction of blade and sheath; 40, margin of blade; 41, fascicle; 42, glume of central spikelet; 43, floret of central spikelet; 44, palea and caryopsis; 45–46, first and second glumes of lateral spikelets; 47–48, lemma and palea of first floret; 49–50, palea and lemma of second floret. All figures ×8 and drawn from the type specimen.

ENTOMOLOGY.—*New Neotropical genera and species of apterous aradids (Hemiptera)*. CARL J. DRAKE, Iowa State College.

(Received August 15, 1956)

The present paper contains the descriptions of one new genus, one subgenus, and five species of apterous aradids from the Americas. The types have been deposited as stated in the descriptions. In the structural measurements, 80 units equal 1 mm.

Emydocoris montanus, n. sp.

Very broad, rather thick, obovate, narrowest across front margin of pronotum, above with a complicated pattern of high elevations and deep cavities, without lateral lobes or projections, dark ferrugineous without color markings, without vestiture. Head broad, subquadrate, width across eyes and median length subequal (2.25 mm). The lateral edges nearly parallel; lateral shelves very wide, long, depressed, with bases almost in contact with front margin of pronotum; eyes moderately large, subovate, about two-thirds as broad as long, each placed at middle of lateral side of lateral shelf, slightly inserted, about three-fifths of its width extending outward beyond the lateral side, the shelf behind the eyes broad; antenniferous tubercles stout, tapering anteriorly, slightly divergent; median longitudinal part of head elevated above lateral shelves, about one-third as wide as interocular space, strongly rugose above, projecting about one-third of its length beyond base of antennae; tylus moderately wide with superior surface smooth and longitudinally convex; juga surpassing tylus, dilated apically, meeting at midline in front of tylus. Labial sulcus deep, narrow, extending to collar; labium short, brownish, nearly attaining end of sulcus. Neck very short, constricted, rounded. Antennae and head subequal in length; antennal segment I quite stout, bent outward opposite apex of antenniferous tubercle; II shortest, slenderest; III slowly enlarged apically; IV subclavate; measurements—I, 45; II, 30; III, 54; IV, 50.

Pronotum a little narrower than mesonotum, narrower in front than behind, sloping obliquely downward anteriorly, approximately 2½ times as wide at base as median length (210:80), with outer sides of dorsal surface very strongly widely and rugosely elevated, strongly depressed between lateral elevations, with the large median plate divided at middle by a deep longitudinal furrow, separated behind from mesonotum by a transverse suture, the collar short, depressed, strongly constricted, with a small knob on each side. Mesonotum separated from metanotum by a strongly sinuate suture, narrower than pronotum, longest at middle, four times as wide at base as median length (longest at middle), with a very wide, convex and smooth median ridge, with lateral elevation not quite as large as on pronotum, with a deep transverse cavity on each side between median ridge and large lateral elevation. Metanotum not attaining outer margin of body, fused with abdominal tergites I–VI (inclusive) into a solid plate, the plate wider at base than behind, width at base (metanotum) and median length subequal, with transverse suture between tergites II and III faintly indicated, with median ridge widened and elevated posteriorly, abruptly widened on tergites II and III, thence posteriorly gently sloping downward, with glandular elevation at centre of widened hind part plainly visible, with dorsal surface of median ridges and elevations smooth and without complex sculpturing, narrowly depressed on each side of the highly elevated area between the longitudinal suture separating tergites from connexival segments, with a deep cavity on each side of median ridge just back of metanotum, with three knoblike structures in cavity just behind metanotum and five transverse ridges in narrowly depressed strip adjacent to each connexivum.

Connexiva slowly narrowed anteriorly, with segments I and II fused, other segments separated from one another by transverse sutures. Spiracles II to VII (inclusive) ventral, remotely removed from outer edge of their respective segments, spiracle VIII (genital segment) placed on apical end of a short, posteriorly-directed tubercle. Body beneath moderately convex; prosternum with a median longitudinal carina, separated from mesosternum by a transverse suture; mesosternum also with a visible suture behind it (probably not functional); metasternum fused with abdominal ventrites I–III (inclusive), other ventrites separated from one another by

deep suture. Legs short, dark brownish ferrugineous with pale tarsi, the femora of all legs slightly flattened beneath and beset with two longitudinal rows (one row near anterior edge and other near posterior) of short, stout, tubercle-like teeth or pegs with rounded tops. Ostiolar canal tubular, extending obliquely upward posteriorly, with an ovate opening slightly above middle of pleura, not visible from dorsal aspect. Scutellum entirely absent, without trace of wings or wing pads.

Length, 8.75–9.20 mm; width, 4.75 mm.

Holotype (male) and *allotype* (female), Brasil, November 29, 1890, collected by Dr. Warburg, in collection of Zoologisches Museum, Zoologisches Staatsinstitut, Hamburg, Germany. *Paratype:* 1 specimen, same locality as type.

Separated from *Emydocoris testidinatus* Usinger (1941) by its larger size, antennal segments, short legs with all femora armed beneath, high elevations and deep cavities of dorsal surface (especially abdomen) and the large tubular ostiolar canal projecting obliquely upward with an ovate opening on outer side.

Reeceicus, n. gen.

Broadly ovate, unusually thick, beneath transversely convex, dorsally strongly longitudinally convex, rugged, humpbacked, adorned on median part of thorax and basal half of abdomen with large craggy protuberances and depressions, with thorax sloping downward anteriorly and abdomen downward posteriorly. Head very wide, subquadrate, not narrowed behind eyes; lateral shelves very wide, thin, with dorsal surfaces on much lower level than that of median longitudinal part of head, tilted upward laterally, with eyes rather small, longer than wide and placed near middle of outer edge of each shelf; tylus fairly wide, rugged; juga narrower, not exceeding tylus in front; neck short. Labial sulcus deep, rather narrow, not extending to neck; labium short, not attaining apex of sulcus. Antennae short, subequal to head in length; segment I short, moderately swollen, bent, not surpassing apices of tylus and juga; other segments also short, with IV a little swollen. Legs rather short, slender.

Pronotum much wider than head, about four times as wide as long, rugged, not excavated in front for reception of collar; collar short, constricted; mesonotum short, rugged, with transverse furrow separating it from pronotum and also from mesonotum (sutures seem to be fused); metanotum partly concealed by raised and overlapping base of abdomen. Thoracic divisions and abdominal tergites I to VI (inclusive) apparently conjointly fused but with a narrow, deep furrow between II and III. Abdomen distinctly broadly cordate, with apex narrow and rounded, with wide basal part a little raised and fused upon base of metanotum, thus together with craggy elevations giving body a distinctly hunchbacked appearance; connexival segments strongly curving inward at base, apparently with segment I represented (seven segments).

Spiracle II ventral, remotely removed from outer margin; III to VII (inclusive) lateral, plainly visible from above; VIII (genital segment) posterolateral, placed at apical end of rounded projection, visible from dorsal aspect.

Type species, *Reeceicus saileri*, n. gen. and n. sp.

This very curious genus differs greatly in a few respects from all other genera of apterous aradids. The body is very thick, broadly ovate, strongly longitudinally convex and distinctly hunchbacked in appearance; lateral sides deeply furrowed for the reception of legs; abdomen above broadly heart-shaped, narrowly rounded behind, with base wide, slightly elevated; connexival segments at base strongly curved inward and fused upon the basal part of metanotum. Connexival segment I appears to be represented as seven segments are visible. Spiracle II is ventral and remotely removed from lateral margin; III to VII (inclusive) placed on low half of the longitudinally divided (by narrow furrow) outer edge of connexiva. The head is rather similar in shape and appearance to *Emydocoris* Usinger (1944), but the smaller eyes, shape of body, location of spiracles and other striking differences separate at once the two genera. This genus and species are named in honor of Dr. Reece I. Sailer, who is in charge of the Hemiptera, U. S. National Museum.

Reeceicus saileri, n. sp.

Fig. 1

Moderately large, very thick, extremely longitudinally convex above, strongly rugged, with a distinctly humped back. Head subquadrate, with sides widening posteriorly, slightly angulately produced at latero-posterior corner, wider at base (100) than either across eyes (70) or between tips of antenniferous tubercules, each lateral shelf occupying one-

FIG. 1.—*Reecevicus sailerí*, n. gen. and sp. Dorsal aspect of abdomen (× 32).

third of space between eyes; juga not surpassing tylus. Antennae short, measurements—I, 20; II, 16; III, 18; IV, 20. Labium short, brownish. Sides of thorax with an oblique, upright channel for reception of anterior femora; with an inverted V-shaped channel for reception of middle femora and tibiae, and the thorax and base of abdomen also with an inverted V-shaped channel for reception of hind femora and tibiae.

Pronotum almost twice as wide as base of head (185:100), nearly four times as wide at base as median length (200:50), not excavated in front for insertion of collar, with a subquadrate protubance at middle; mesonotum not longer than pronotum, with the protuberance of mesometanotum higher and more deeply furrowed at middle than similar structure on pronotum. Abdomen broadly heart-shaped, widest near base, roundly narrowed posteriorly, rounded and narrowest behind, subtruncate at middle of front margin, tilted upward anteriorly, with base fused up on posterior part of metanotum, with connexiva curving inward and extending along anterior part of base of abdomen, with basal platelike protuberance large, trapezoidal (basal and apical margins parallel and long; sides obliquely widened apically), divided into four equal parts by three longitudinal furrows (median furrow and one on each side of it); tumid area behind furrow between tergites II and III quite large. Connexiva composed of seven segments (I present), curving strongly inward at base so as to occupy two-sevenths of basal margin on each side, thus leaving only three-sevenths of base at middle). Exterior margin of abdomen rather thick, with edge divided by a narrow longitudinal furrow, with stigmata III to VII (inclusive) placed on lower half of lateral edge, all spiracles (save II) visible from dorsal view.

Length, 4.50 mm; width, 2.90 mm.

Holotype (female), Yurimaguas, Peru, Drake Collection.

Glyptocoris verus, n. sp.

Large, broadly ovate, widest across middle of abdomen, narrowest across front margin of pronotum and there very little wider than head

across eyes, reddish ferrugineous with abdomen darker and a small marginal spot on each side at base of all thoracic divisions and of all connexival segments pale or whitish flavous. Head quadrate, as wide across eyes as median length (86:88), strongly rugose above; lateral shelves thick, with dorsal surface on a slightly lower level than that of median longitudinal part of head, extending posteriorly behind eyes nearly the length of an eye before narrowing to neck, with an angulate lateral projection or tubercle behind each eye at postero-lateral end; median longitudinal part of head a little narrower than a lateral shelf, with a small tubercle on each side just in front of neck; tylus moderately stout, rugose, sloping downward at apex; juga surpassing tylus about as far as the distance between their apices. Labial sulcus short, wide, fairly deep, with edges and lateral sides closely coarsely granulate; labium barely attaining end of sulcus. Antennae longer than head, granulate; segment I stout, a little bent outward; IV subclavate, with short pale hairs on tip; measurements—I, 52, II, 32; III, 42; IV, 34. Legs slender, finely granulate.

Pronotum strongly narrowed anteriorly, much wider behind than in front, closely granulate on lateral sides, deeply rectangularly excavated on margin for reception of collar, with margin on each side projected anteriorly as far as anterior face of collar, deeply widely furrowed on median longitudinal line behind the middle, with a transverse furrow separating pronotum and mesonotum, twice as wide in front as median length, three times as wide at base as median length (160:50); mesonotum wider and shorter than pronotum, with a shallow furrow separating it from metanotum; metanotum longer than pronotum, with its hind margin elevated although fused with first two abdominal tergites; pro-, meso- and metanotum and abdominal tergites I and II conjointly fused, with a wide, median, longitudinal ridge extending uninterruptedly from base of pronotum to end of tergite II, with short lateral ridges on each side of median line of large median ridge. Abdomen above with tergites III to VI (inclusive) conjointly fused, sculptured on each side of low, wide, pale, median, longitudinal ridge; connexival segments I to III fused together, the others distinctly sutured from one another. Body beneath with sternal segments and first three abdominal ventrites conjoined together, other abdominal ventrites separated by sutures. Spiracles V, VI and VII lateral; VIII (genital) placed on end of posteriorly directed tubercle; and II, III and IV ventral, the latter subventral, III considerably removed from outer edge and II remotely removed, all three not visible from dorsal aspect. Male unknown.

Length, 6.20 mm; width, 3.10 mm.

Holotype (female) and 1 *paratype* (female), Guadeloupe Island, West Indies. Drake Collection.

Although somewhat atypical, this species fits better in the genus *Glyptocoris* than other genera of American apterous aradids. The thoracic divisions are distinguishable from one another, though fused together and also conjoined with first two abdominal tergites.

Aglaocoris comes, n. sp.

Small, rectangular in outline, reddish fuscous or reddish ferrugineous, without lateral lobes, coarsely granulate on lateral margins of thorax and abdomen. Head subtriangular, rapidly narrowed behind eyes, with a short neck, width across eyes and median longitudinal length subequal; eyes small, reddish, placed up on the outer end of a very short, slightly tilted-up pedicel; juga surpassing tylus, with tips blunt and feebly divergent, with dorsal surface on a much lower level than that of tylus; tylus rugose, fairly thick; lateral shelves and median part of head rather strongly rugulose, with dorsal surfaces on almost same horizontal level, the shelves thick and each about as wide as median part of head, with a small protuberance back of each eye; antennifferous tubercles stout, divergent, each terminating in a small fingerlike projection. Labial sulcus moderately wide, not extending to neck; labium not as long as sulcus. Antennae granulate, longer than head, with first segment slightly bent outward, measurements—I, 36; II, 30; III, 24; IV, 24. Legs moderately long, granulate.

Body nearly as wide in front as behind (72:75), slightly wider at middle (90), with median length nearly one and one-half times as long as median with (130:90). Pronotum more than four times as wide at base as median length, scarcely excavated in front for reception of collar, sulcate on median longutidinal line; collar smooth, short and with an encircling median ridge, marked off from mesonotum by a transverse furrow, fused with mesonotum. Pro-, meso-, and metanotum and abdominal tergites I and II conjointly fused, with a large median longitudinal ridge extending

from base of pronotum almost to posterior margin of tergite II, the ridge strongly rugose, wider and higher on basal half. Abdomen with tergites III to VI (inclusive) fused together, with a tumid glandular elevation near the middle of the low, median, longitudinal ridge, with an intricate pattern of sculpturing on each side of median ridge; VII distinctly defined; connexival segments I, II and III grown together, without separating sutures, other segments sutured from one another and from abdominal tergites. Abdomen beneath with sternal division and ventrites I-III (inclusive) conjointly fused, other segments sutured from one another. Spiracles II to IV (inclusive), ventral, submarginal, each progressively anteriorly slightly farther removed from outer edge; V sublateral (ventral) and VI and VII lateral and VIII postero-lateral on end of a short rounded process, all four of which are visible from dorsal aspect. Abdominal ventrite VII beneath (one on each side) with a large ovately rounded, smooth, constricted at neck (distinctly bottle-shaped), ventrally-directed protuberance (male structre; not found in female).

Holotype (male) and 1 *paratype* (male), Three Rivers, Guadeloupe, West Indies, in Drake Collection.

Separated from *A. natalii* Drake and Maldonado by its smaller size, shorter eye-stalks, median longitudinal ridge on pronotum and the much larger and very differently shaped (flask-like) protuberance projected downward on the underside of ventrite VII (one on each side) in the male.

Asterocoris (Peggicoris) zeteki, n. subg. and n. sp.

Small, oblong (male) or obovate (female), dark reddish fuscous or ferrugineous. Head subtriangular, width across eyes and median longitudinal length subequal, sharply narrowed behind eyes, with the small elevation back of each eye beset with setalike, whitish hairs; tylus moderately stout, feebly narrowed anteriorly, with dorsal surface on a higher level than that of juga; juga scarcely exceeding tylus, each jugum with one or two, long, stiff, setalike hairs projecting anteriorly from its apex (sometimes hairs are rubbed off); median longitudinal part of head narrower than each lateral shelf, smooth, with a moderately large rounded elevation on median line between bases of lateral shelves; neck short, with a small tubercle on each side; eyes small, reddish, pedicellate, with short stalk slightly tilted upward; antenniferous tubercles short, stout, rounded apically. Labial sulcus very wide, short, shallow, not reaching to neck; labium brownish, not reaching to end of sulcus. Antennae long, reaching beyond pronotum; segment I very long, extending three-fourths of its length beyond apices of juga, rather densely clothed with stiff, setalike, whitish hairs which are as long as width of segment at their respective points or origin; other segments with shorter hairs; measurements—I, 74; II, 26; III, 34; IV, 30.

Pro-, meso-, and metanotum and abdominal tergites I and II fused together; median longitudinal ridge large and smooth, without transverse sutures, tapering a little anteriorly, extending from base of tergite II anteriorly to collar, with the thoracic divisions on each side of median ridge indicated by transverse furrows. Abdominal tergites III to VI (inclusive) conjointly fused, with a large, median longitudinal ridge, the sculptured areas on each side of ridge rather shallow; connexival segments (except I and II fused) separated from one another and from abdominal tergites by sutures. Body beneath with the three sternal divisions and first three abdominal segments conjointly fused, the other ventrites separated from one another by sutures. Ostiolar channel not extending upward to dorsal surface, thus not visible from above. Lateral margins of body with several small tufts of short, setalike, whitish hairs. Legs fairly long, slender, sparsely clothed with short, coarse, whitish hairs.

Spiracles placed up on top of small elevations, the elevations slightly higher in male than in female; spiracles II, III and IV ventral, not visible from dorsal aspect; V sublateral (ventral) and VI, VII and VIII (genital segment) lateral and all visible from above.

Length, 3.90–4.40 mm; width, 1.74–2.10 mm.

Holotype (male) and *allotype* (female), Barro Colorado, Canal Zone, Panama, 1948, take by means of Berlese funnel from forest litter, by James Zetek, in U. S. National Museum. *Paratypes:* 5 specimens, same labels as type. Named in honor of Mr. Zetek, who has collected so many rare and interesting insects in Panama.

The new subgenus *Peggicoris* differs from *Asterocoris*, s. str., by the lack of long lateral lobes on body, position of spiracles, short juga, fusion of thoracic divisions and location of ostiolar channel.

Aglaocoris cubanus, n. sp.

Small, oblong (male) or obovate (female), without lateral lobes, depressed above, finely shallowly sculptured. Head subtriangular, width across eyes and median length subequal (82:85); tylus moderately wide, rugose, with dorsal surface on a higher level than that of juga; juga thin, feebly surpassing tylus; lateral shelves nearly as wide as and with dorsal surface on same level as that of median longitudinal part of head; eyes small, pedicellate, with short stalk nearly horizontal; antenniferous tubercles moderately large, tapering anteriorly, with apices blunt; neck short, constricted, with a small tubercle on each side of outer edge of dorsal surface. Labial sulcus short, very wide, moderately deep, not extending to neck; labium scarcely attaining apex of sulcus. Antennae granulate, longer than head, with segment I extending three-fourths of its length beyond apices of juga, measurements—I, 40; II, 26; III, 30; IV, 24.

Pronotum strongly narrowed anteriorly, wider in front than width across eyes, deeply widely triangularly excavated in front for reception of large collar, with front margin beyond collar extending anteriorly as far as anterior margin of collar, with a small tubercle (one on each side) on antero-inner margin of front projection extending inward to collar; collar large, smooth, with a deep, median, encircling sulcus; mesonotum wider than and practically same length as pronotum, separated by furrows from both pro- and metanotum. Three thoracic divisions and abdominal tergites I and II bused together, with a very low, wide, median ridge extending from basal part of pronotum to apex of tergite II, with dorsal surface pretty much covered with many small, longitudinal ridges. Abdomen with tergites III to VI (inclusive) fused, shallowly sculptured, with a small discal elevation on low median ridge; connexival segments (save I and II fused) sutured from one another and also from tergites. Spiracles II, III and IV ventral, not visible from above; V subventral, scarcely visible from above; VI, VII and VIII (genital segment) all lateral and plainly visible from dorsal aspect. VII ventrite (male) with a small, rounded, bottle-shaped projection (one on each side; directed downward), with constricted neck.

Length, 4.75 mm (male) and 5.50 mm (female); width 2.20 mm (male) and 2.75 mm (female).

Holotype (male) and *allotype* (female), Cayamas, Cuba, in Drake Collection.

Distinguished from its congeners by shape of body, deeply broadly excised anterior margin of pronotum for reception of collar and by shape of male protuberances on underside of abdominal ventrite VII.

"PINE CONE" FISHES

There are fishes in the sea that when alive look like swimming pine cones. When dead and dried they actually could be mistaken at first sight for pine cones. They belong to quite a distinctive genus, *Monocentris*, which has an isolated niche in ocean life. They do not seem related to anything else.

A unique specimen taken off the Robinson Crusoe island, Juan Fernández, off the coast of Chile, by Dr. Edwyn P. Reed, chief of the biological service of the Chilean Fish and Game Department, has just been identified at the U. S. National Museum, Smithsonian Institution, by Dr. Leonard P. Schultz, curator of fishes, who has described it as a hitherto unknown species, the first of the entire family known in the American Pacific.

The "pine cones" are small fishes, the largest slightly more than 3 inches long. They are rare anywhere. The habitat with which they were associated was the tropical western and central Pacific until they were found at considerable depths in the eastern Pacific. One genus "carries lanterns," that is, luminous organs, on each side of the mouth, as do many other oceanic fishes.

HERPETOLOGY.—Hyla cinerea *in Maryland, Delaware, and Virginia, with notes on the taxonomic status of* Hyla cinerea evittata.[1]

CLYDE F. REED, Baltimore, Md. (Communicated by Doris M. Cochran.)

(Received August 13, 1956)

The latest checklist of North American amphibians and reptiles, by Karl P. Schmidt (pp. 69–70, 1953), is quite inaccurate in its distribution of *Hyla cinerea* (Schneider). It states that *Hyla cinerea cinerea* ranges in the "lowlands of the Atlantic and Gulf States from Virginia to Texas; north in the Mississippi Basin to southern Illinois." The range for *Hyla cinerea evittata* Miller is given as "The Delmarva Peninsula, eastern Maryland and adjacent Virginia." From these two statements one would conclude that *evittata* was a distinct northern subspecies with geographic limitations. Schmidt has indicated such to be the case by calling *evittata* the northern green tree frog.

The purpose of this paper is to show that the taxon *evittata* should be reduced to the synonymy of *Hyla cinerea* (Schneider), since none of the characters upon which *evittata* was originally based hold up as distinguishing it as a biological entity from other populations of *Hyla cinerea*.

The problem developed from the instigation of the new taxon *Hyla evittata* by G. S. Miller, who separated *evittata* from *cinerea* on the basis of the absence of the lateral bright stripe in the former, as the name *evittata* implies, together with the characters a broader head and a higher snout.

Hyla evittata Miller, Proc. Biol. Soc. Washington **13:** 76. Sept. 28, 1899. Type adult male (in alcohol) U. S. Nat. Mus., Washington no. 26, 291, collected at "Four Mile Run, Alexandria County, Virginia," July 15, 1898, by Gerrit S. Miller, Jr., and Edward A. Preble.

There are several matters concerning the type that are misleading. First, the type label reads "Four Mile Run, D. C." The type specimen is accessioned as "Four Mile Run, Virginia." Four Mile Run is near the city of Alexandria, but I have been unable to find an Alexandria County, even in 1899. There was an Arlington County, in which Alexandria was a city. At the present Alexandria is an independent city (no county).

Second, the date on the type specimen is July 15, 1899, not July 15, 1898, as quoted in Miller's original publication, and by Wright and Wright (*Handbook of frogs and toads*, p. 310), which is a quotation of the original description. The type specimen is also accessioned as being collected July 15, 1899.

Third, the pagination for the description of the type of *Hyla evittata* is page 76, not page 75 as cited in Schmidt's checklist (p. 70), who gives the location of Four Mile Run as Fairfax County, Va. There is nothing to indicate the name of the new species on page 75. Besides, the description is really on page 76.

Fourth, the date of publication is September 28, 1899, not August 1899, as indicated on the type label.

Fifth, concerning the paratypes, at least those specimens designated as paratypes: There are four specimens in the U.S. National Museum which are designated as paratypes, collected at Four Mile Run, Va., July 15, 1898. U.S.N.M. nos. 66207, 66209, and 66210 have no stripes, while no. 66208 has a long stripe. These four specimens are referred to only by inference in the original article by Miller, and the museum numbers are not cited. However, Miller probably did have these specimens before him while describing the new species, and in the broadest sense of the term could be considered paratypes. However, from the measurements given below he did not include theirs with that of the type. When their measurements are included, the range is well within that of typical *Hyla cinerea*.

Three other specimens are also designated as paratypes, collected at Four Mile Run, Va., July 4, 1901. Since these could not have been seen at the time the new species was described (1899), they are topotypes and not paratypes, U.S.N.M. nos. 29652–29654. Two of these have no stripes, while the third has a white upper lip back to the axial of the jaw.

Sixth, Miller states concerning the general characteristics, "Like *Hyla cinerea* (Daudin), but with broader, deeper muzzle and normally un-

[1] Contribution to the Herpetology of Maryland and Delmarva, no. 4.

striped body and legs." *Hyla cinerea* was originally described by Schneider, Hist. Amph. **1:** 174. 1799, as *Calamita cinereus*. Daudin described *Hyla lateralis*, in Sonnini and Latreille, Hist. Nat. Rep. **2:** 180. 1802, from Charleston, S. C. This is considered a synonym of *Hyla cinerea* (Schneider).

Because of the confusion and uncertainity which accrues when these criteria are used in identifying specimens from Maryland, Delaware, and the main estuaries of the Chesapeake Bay, as the Potomac, Patuxent, Gunpowder (including Bird River and Dundee Creek), Elk, Sassafras, Choptank, Nanticoke, Pocomoke, York, and James Rivers, reviews of these criteria were made by Noble and Hassler (Copeia 1936(1): 63) for southern Maryland species and by Dunn (Proc. Biol. Soc. Washington **50:** 9–10. 1937) upon the stratus of *H. evittata*, based on 126 specimens from Virginia and Maryland.

In describing *Hyla evittata*, Miller (1899) had noted that the lateral strips may be reduced in length in some specimens of *Hyla cinerea*. This phenomenon was considered a rare variation by him. However, the short stripe occurs in nearly all the populations in our region, a situation which has lead to the belief that we are dealing with intermediates or hybrids. These concepts will be discussed later. There is a tendency for the more northern populations of *H. cinerea* to have some individuals with shorter or even no stripes. According to Miller it was head shape and not the body stripe which distinguished *evittata* from the typical form.

Noble and Hassler (Copeia 1936(1): 63) studied a population of *Hyla cinerea* (32 specimens from Cove Point, Calvert County, Md.) in which some lacked the light stripes along the sides of the body; some had only a tinge of white on the posterior part of the upper jaw; some had stripes which extended beyond the tympanum and faded out on the sides of the body. Specimens from Wilmington, North Carolina, reported by Myers (Copeia 1924, no. **131:** 60) and restudied in the American Museum by Noble and Hassler showed a similar situation (14 adults studied—2 without stripes, 4 with partial stripes, 8 with full stripes).

Seven statements in the original description of *Hyla evittata* lead one to think that Miller was not too sure that his was a new species. For example, "*Hyla evittata* is at once distinguishable from *H. cinerea* by the absence of the stripes on sides and legs, so conspicuous in the latter". Yet he cites specimens from Mississippi and Louisiana that have no stripes. "Except for the difference in the shape of the head, the two animals (the type and *H. cinerea* from Bay St. Louis, Mississippi) agree perfectly in form and dimensions." Dunn has discounted the value of the head measurements in separating two populations as subspecies. "*Hyla evittata* probably averages slightly larger than *H. cinerea*." All that are mentioned in the paper are the measurements of the type and the *H. cinerea* specimen from Mississippi. Head and body lengths are the same—48 mm; hind leg—69 and 68; femur same—20; tibia same—21; tarsus same—11; hind foot—17 and 15; humerus—8 and 9; forearm—8 and 9; front foot same—10; greatest width of head—14 and 13. Concerning the eye to nostral measurements the type is 3.5 and *H. cinerea* 4; and the distance between the nostrils is 3.5 and 2.5. These figures would indicate the distance from the eye to the nostril was shorter in *H. evittata* than in *H. cinerea*, and that the distance between the nostrils was wider. However, if we include the same measurements of the seven specimens designated as the "paratypes" of *H. evittata*, we get a different ratio.

	Eye to nostril	Nostril to nostril
U.S.N.M. no. 66207	4.5	4.0
66208	4.0	3.0
66209	4.0	3.5
66210	4.0	3.5
29652	4.0	3.0
29653	4.0	3.5
29654	4.0	4.0

These figures indicate that the eye to nostril distance is 4.0 mm, which is the same as that for the *Hyla cinerea* compared with the type by Miller. The nostril-to-nostril measurement averages 3.5 mm. However, the nostril-to-nostril measurements on 20 specimens collected by Reed or Daffin in Maryland, Virginia, and Delaware average 3.5 mm also. So this variation is within the normal deviation of a population within the species.

"The granulation of the skin of belly and hind legs is identical in the two animals."

Noble and Hassler, as well as Dunn, concluded from their studies that *evittata* and *cinerea* could not be separated by the head width or slope to the snout. The former say that the series of *evittata* in the American Museum differ from the Cove Point specimens of *cinerea* in having a more vertical, less sloping profile to the snout. Con-

cerning the width of the head, which is said to be broader in *evittata*, they state that their series of *cinerea* exhibited a great variation in width and no constant difference could be found. Dunn agreed with this conclusion and added that the type and topotypes of *H. evittata* could not be separated from Carolina *cinerea* with any degree of certainty. Dunn also noted that in many species of Hylidae the male has a sloping snout and the female a blunt one: this may be the case in *cinerea* and *evittata*. So far as is known to the present author, no one has sexed the museum specimens of *evittata* and *cinerea* now available for study, nor has anyone determined whether the sexes are morphologically dimorphic.

Having discounted the characteristics of the head as distinguishing *evittata* from *cinerea*. Dunn rested the status of *evittata* upon the lateral stripes. From his study of 126 specimens from Virginia and Maryland he reported 81 percent of the upper tidewater Potomac populations with no stripes or short ones; 41 percent of the other Maryland and Virginia specimens with no stripes or short ones; 25 per cent of the North Carolina specimens with no stripes or short ones; and all the Gulf coast specimens with long stripes. This population study would indicate that northern colonies have a tendency to decrease the length of the lateral stripes to the point of obliteration. That this factor alone constitutes the basis of a new species or even a new subspecies is not substantiated by the study of the specimens at hand.

Miller stated that unstriped specimens from Bay St. Louis, Miss., and from New Orleans, La., had been seen by him. Thus, all (as stated by Dunn) of the Gulf coast populations do not have long stripes. Also, specimens with no stripes have been reported from North Carolina (stated above, 25 per cent) and from Maryland and Virginia other than from the type locality of *H. evittata*. Thus, throughout most of the range of *Hyla cinerea* specimens with no stripes or with partial stripes have been found, with a tendency for those populations northward to exhibit a greater percentage of the population to have shortened or obliterated stripes.

Contradictory to Schmidt's distribution, Dunn concluded from his study of *evittata* and *cinerea* that "*H. cinerea evittata* is unknown from Delaware and from the eastern side of the Delmarva Peninsula." Dunn's *evittata* had no stripes, and on this basis his statement is likewise untenable in the light of collections by the author and Ralph Daffin. Daffin has collected *H. cinerea* with long and short stripes (in a proportion of 50–50) at Ocean Downs just west of Ocean City, which is very near the Atlantic Ocean on the eastern side of the Delmarva Peninsula, and the author has collected specimens with no stripes in Accomac County, Va., on the eastern side of the Delmarva Peninsula also. Selbyville, Sussex County, Del., is near the eastern coast.

Because of the occasional short stripe and long stripe in the same population, Conant (Publ. Soc., Nat. Hist. Delaware 1945: 4) concluded that the populations of *Hyla cinerea* inhabiting the Delmarva Peninsula were intermediate between the two subspecies. Some herpetologists have gone so far as to assume that there are two subspecies or species in our region and to call these populations hybrids, designating them as *Hyla cinerea cinerea* × *evittata*. Such conclusions have been based upon phenotypic characteristics and to the best of my knowledge have not been substantiated by experimentation nor even observation.

Beside the specimens in the United States National Museum which were carefully studied, including the type and topotypes of *Hyla evittata*, the author has collected and studied specimens from several new localities in Maryland, Delaware, and Virginia. The type locality for *H. evittata*, Four Mile Run, in Fairfax County, Va., was visited by the author on July 17, 1956. None of the frogs were heard calling at that time.

The material collected or studied by the author from Worcester and Wicomico Counties, Md., and from Accomac County, Va., indicates that all three striped types may be found in pure or mixed populations on the Delmarva Peninsula. The specimens from the Accomac County locality have no stripes; those from Ocean Downs have about 50–50 short and long stripes; and those from the Nanticoke River at Vienna (Wicomico-Dorchester County) have long stripes.

Representative specimens from localities in Maryland, Delaware, and the vicinity of the District of Columbia, including the type locality of *H. evittata* in Virginia, have been studied and are listed below. The most northern locality on the Delmarva Peninsula for *Hyla cinerea* is the Chesapeake and Delaware Canal which connects the Delaware River with the Elk River, which in

turn leads to the Cheaspeake Bay. West of the Chesapeake Bay the most northern locality is in Baltimore County along the Chesapeake Bay along two estuaries of the Gunpowder River, Dundee Creek and Bird River, just north and east of Chase (Daffin 506–507 and Reed 1191).

MARYLAND: *St. Marys County*: Hay's Beach near Ridge (Cooper, l.c., 1953); *Charles County*: Nanjemoy Swamp near Riverside, July 1935, Reed. *Calvert County*: Abundant between Cove Point and Solomons Island (Noble and Hassler, l.c., 1936, 32 specimens typical *cinerea*, Amer. Mus.); Cove Point (Putens, Bull. Nat. Hist. Maryland **6**(9): 57. 1936). *Anne Arundel County*: Ritchie Highway between Magothy and Severn Rivers, July 1956, Robert Simmons. *Baltimore County*: Dundee Creek and Bird River, near Chase along Grace's Quarters Road, June 25–26, 1956, Ralph Daffin 506–507, Reed 1191, Donald Lindsey 1–4. *Cecil County*: West end of Chesapeake-Delaware Canal, M. Joseph Cadbury (see Dunn, Proc. Biol. Soc. Washington **50**: 10. 1937). *Cecil-Kent County*: Georgetown, on Sassafras River, July 20, 1915, Paul Lorrilliere (as *H. evittata*) (see Fowler, Copeia 1915, no. **22**: 38) (note: Georgetown is in Kent County, which lies to the south of the Sassafras River, but the record states the specimen is from Cecil County). *Queen Annes County*: Near Centerville, June 23, 1938, R. H. McCauley (U.S.N.M. nos. 104446–50), and July 15, 1938, R. H. McCauley (U.S.N.M. nos. 104457). *Talbot County*: Easton, H. L. Clark, September 8, 1903 (U.S.N.M. no. 32106). *Dorchester County*: Cambridge, June 1928 (U.S.N.M. nos. 75287–8); Lloyds, W. P. Hay, June 1906 (U.S.N.M. nos. 36673–82), July 9, 1906 (U.S.N.M. nos. 100840–6), July 1907 (U.S.N.M. nos. 37833–7); Cambridge, September 1933, R. W. Jackson (U.S.N.M. no. 92598); Blackwater Refuge, 10 miles south of Cambridge. July 25, 1938, R. H. McCauley (U.S.N.M. nos. 104463–77). *Dorchester-Wicomico County*: Along Nanticoke River on both sides of the river, several large colonies, July 9, 1956, Reed 1150–51. *Worcester County*: Cedar Hall, June 27, 1938, R. H. McCauley (U.S.N.M. nos. 104451–6); pond 5 miles west of Ocean City at Ocean Downs, June 15, 1956, Ralph Daffin 458 and 545–554; swamp south of Pocomoke City, July 9, 1956, Reed; meadow, Girdletree, July 10, 1956, Reed.

VIRGINIA–EASTERN SHORE: *Accomac County*: 2 miles south of Oak Hall, July 9, 1956, Reed 1107. *Accomac-Northampton County*: Exmore, June 1938, M. K. Brady (USNM nos. 75277–86).

VIRGINIA—along POTOMAC RIVER: *Fairfax County*: Four Mile Run (TYPE LOCALITY for *Hyla evittata*), July 15, 1899 (not 1898, as stated by Wright and Wright in *Handbook of frogs and toads*, p. 310. Also there is no Alexandria County in Virginia), Gerrit S. Miller, Jr., and Edward A. Preble (U.S.N.M. no. 26291); paratypes, same locality, July 15, 1898 (U.S.N.M. nos. 66207–10), E. A. Preble, July 1898 (U.S.N.M. no. 45967); G. S. Miller, July 4, 1901 (U.S.N.M. nos. 29652–54); P. Bartsch, 1935 (U.S.N.M. no. 101170); Dyke, below Alexandria, September 17, 1898, G. S. Miller. (U.S.N.M. no. 66211); Alexandria, July 3, 1912, J. Hunter (U.S.N.M. nos. 58085–6); New Alexandria, E. T. Wherry, September 1923 (U.S.N.M. no. 66327); Dogue Creek, near Fort Belvoir, June 4, 1939, H. J. Cole (U.S.N.M. nos. 127467–85); Little Hunting Creek, May 28, 1911, W. D. Appel (U.S.N.M. nos. 55443–4); 1923, M. K. Brady (U.S.N.M. nos 66474–75); Mount Vernon, W. P. Hay, October 15, 1892 (U.S.N.M. nos. 39911–12); June 1893 (U.S.N.M. nos. 20891–33); E. A. Preble, October 28, 1900 (U.S.N.M. nos. 27742). *Prince William County*: Quantico, October 13, 1901, G. S. Miller (U.S.N.M. nos. 29620–21).

DISTRICT OF COLUMBIA: Washington, July 1, 1933, I. E. Gray (U.S.N.M. no. 91745, as *cinerea*); Oxon Run Marsh, August 1935, Perrygo & East (U.S.N.M. nos. 101159–69, as *evittata*); Oxon Run, July 13, 1936, C. S. East (U.S.N.M. nos. 107690–9, as *evittata*); August 1935 (U.S.N.M. nos. 101434; 101159–69) (Oxon Run borders Prince Georges County to the south side of the District of Columbia).

DELAWARE: *Sussex County*: Meadow near Selbyville, July 10–11, 1956, Reed.

FIG. 1.—Distribution of *Hyla cinerea* (Schneider) in Maryland, Delaware, and Virginia.

For the Delmarva Peninsula, Roger Conant (Publ. Soc. Nat. Hist. Delaware 1945: 4) listed Cecil, Dorchester, Kent (Md.), Northampton, Sussex, Talbot, and Worcester Counties, without giving any specific records.

Hyla cinerea (Schneider), Garman, Bull. Illinois State Lab. Nat. Hist. **3:** 189. 1891, based on *Calamita cinereus* Schneider, *Hist. Amph.* **1:** 174. 1799. Syn.: *Hyla cinerea cinerea* Stejneger and Barbour, Checklist, ed. 2: 30. 1923; *Hyla bilineata* Shaw, Gen. Zool. 3: 136. 1802; *Hyla lateralis* Daudin, in Sonnini and Latreille, Hist. Nat. Rept. **2:** 180. 1802; *Hyla semifasciata* Hallowell, Proc. Acad. Nat. Sci. Philadelphia **8:** 307. 1856; *Hyla evittata* Miller, Proc. Biol. Soc. Washington **13:** 76. 1899; *Hyla cinerea evittata* Stejneger & Barbour, Checklist, ed. 2: 30. 1923.

Range: Delaware (Sussex County) and Maryland (Baltimore County & Cecil County) southward along the Potomac River and south to Florida, westward in the Gulf States to Texas: and north in the Mississippi Basin to southern Illinois.

Concerning the range of *Hyla cinerea* in Virginia, there seems to be a gap on the peninsula between the Potomac River and the Rappahannock River (Northern Neck) and the peninsula between the Rappahannock River and the York River. However, at the mouth of the York River, southward around on the James River and up to Surry County, Va., *Hyla cinerea* and specimens designated as *H. cinerea* × *evittata* have been collected. Also, across the mouth of the Chesapeake Bay in Princess Anne County, *Hyla cinerea* and the putative hybrids have been collected.

The author has collected four years on Northern Neck and has been unable to find *Hyla cinerea*. Several plants and animals are found on the southern side of the Potomac River but not on the northern side; as *Eumeces inexpectatus*, and the plants *Galax aphylla*, *Asarum virginicum*, and *Oxydendrum arboreum*. Several plants are known which range from the York–James Peninsula and Princess Anne County region to the eastern shore of Virginia, most notable being *Trillium pusillum* var. *virginianum*, *Xanthoxylum clava-herculis*, and *Baptisia alba*. *Hyla cinerea* also seems to follow this pattern of distribution, with the exception that it has migrated further northward and westward. Cypress went up the inner side of the Delmarva Peninsula into Pungoteague and up the Pocomoke River, as well as up the western shore of the Chesapeake Bay, especially up the Patuxent River. Specimens of *Hyla cinerea* from the two remaining peninsulas of Virginia are highly desirable to complete our picture for the distribution of *Hyla cinerea* in the Maryland–Virginia–Delware region.

The specimens studied from the lower Chesapeake Bay region of Virginia are listed below.

VIRGINIA: *York County*; Yorktown, June 22, 1948, R. L. Hoffman (U.S.N.M. nos. 131634–6), near mouth of York River. *Elizabeth City County*: Hampton, May 1903, G. S. Miller (U.S.N.M. nos. 31662–5); same, but grouped as *H. cinerea* X *evittata*, May 1903, G. S. Miller (U.S.N.M. nos. 31659–61). *Warwick County*: Menchville, August 2, 1949, R. L. Hoffman (U.S.N.M. nos. 131940–2). *Surry County*: A. H. Jennings, May 1917 (U.S.N.M. no. 59879), as *H. cinerea* X *evittata*. *Princess Anne County*: Virginia Beach, July 13, 1928, H. E. Ewing & C. S. East (U.S.N.M. nos. 75377–81); Sand Bridge, August 6, 1946, Hoffman & Kleinpeter (U.S.N.M. no. 133696); between Pungo and Sigma, August 1, 1946, Hoffman & Kleinpeter (U.S.N.M. no. 124860), as *H. cinerea* X *evittata*.

In conclusion, it is fairly well established that there exists no definite set of factors which would distinguish two distinct species or subspecies of *Hyla cinerea*. Therefore, taxonomically all specimens heretofore designated as *Hyla cinerea evittata* or *Hyla evittata* should be designated as *Hyla cinerea*.

The substitution of analogy for fact is the bane of chemical philosophy; the legitimate use of analogy is to connect facts together and to guide to new experiments.—H. DAVY

ZOOLOGY.—*Ostracoda from bromeliads in Jamaica and Florida.* WILLIS L. TRESSLER,[1] U. S. Navy Hydrographic Office.

The presence of a distinct fauna existing in the water entrapped in the leaf cups of bromeliads has been known for many years. Müller (1880) first reported upon this unique fauna from observations made in southern Brazil. An elaborate study of the bromeliad leaf-cup fauna was later made by Picado (1913), and since then reports have been made on the fauna of isolated regions. The present author (Tressler, 1941) summarized the findings of previous writers and reported on two ostracods which were found in leaf cups of bromeliads from Puerto Rico. Of these, one was a species of the little-known genus *Metacypris*, which was described as a new species (*Metacypris maracaoensis*); the other, *Candonopsis kingsleyii*, while known from several areas, was reported for the first time from bromeliads. Other ostracods previously reported from bromeliads include *Metacypris bromeliarum* (Müller, 1881) and two species imperfectly described by Picado (1913) from Costa Rica. The present paper adds two more species of Ostracoda to the bromeliad fauna and reports on new locations for two species already described from this habitat; *Candonopsis anisitsi* described from Paraguay by Daday (1905), previously has not been known from bromeliads, while a new species of Metacypris, *M. laesslei* is described for the first time. New locations are given for *Metacypris bromeliarum* and *M. maracaoensis*.

The present report is based upon an extensive collection made from bromeliad leaf cups by Dr. Albert M. Laessle of the Department of Biology, University of Florida, during the summer of 1952. Careful samplings were made of the outer and inner leaf cups of the same plant and from different plants in a number of widely separated areas on the island of Jamaica and from three areas in southern Florida. Nearly 100 samples were found to contain ostracods. In many instances a chemical analysis was made of the entrapped water.

The slides of the dissected specimens have been deposited in the U. S. National Museum as type specimens.

[1] The opinions expressed in this report are the author's own and do not reflect those of the Hydrographic Office or the U. S. Navy.

DISTRIBUTION AND ECOLOGY

Collections on the island of Jamaica were made from coastal areas of little or no elevation and from five regions located in the main central mountain chain extending east and west along the axis of the island. Here, elevations of 2,000 feet to 4,500 feet are found. Coastal areas include, from east to west, Ecclestown (800 feet), and Portland Parish (less than 1,000 feet), at the southern tip of the island; Union Hill (500 feet) in the north central portion; Hermitage Dam (1,500 feet) just north of Kingston; Lucca (slight elevation) and Negril (slight elevation) at the extreme western tip of the island. The mountainous areas, from east to west include Hardware Gap (4,500 feet), other areas in the Blue Mountains (elevations from 3,200 to 4,000 feet); Juan de Bolas (2,500 feet); Christiana (3,000 feet); and Mocho (2,000 feet).

The distribution of ostracod species identified appears to be irregular and conforms to no pattern of altitude or nature of the soil. Ecclestown, Union Hill, Christiana, Mocho, Lucca, and Negril are in limestone regions, while the others, namely, Portland Parish, the Blue Mountains, Hermitage Dam, and Juan de Bolas are in noncalcareous areas. The single new species described, *Metacypris laesslei*, appears to be restricted to elevations of 2,000 feet and over, being found only at Mocho, Christiana, Hardware Gap, and in St. Andrews Parish at Silver Hill Gap in the Blue Mountains.

A detailed report on the analysis of water samples taken from leaf cup reservoirs will be given in a final report on these collections by Dr. Laessle. It is sufficient for the purpose of the present taxonomic report to state that the ostracods were collected from water samples displaying a wide range of environmental conditions. Dissolved oxygen readings ranged from practically zero to 8 p.p.m.; carbon dioxide varied from 5 p.p.m. to 40 p.p.m., while pH readings ranged from pH 4.0 to 7.0 and averaged pH 5.0. Most

species of ostracods are very tolerant of wide fluctuations in environmental factors and will exist under conditions of oxygen depletion, pollution, and other unfavorable environmental conditions after other forms have perished. Some species are known to creep along the under surface of the surface film, apparently to secure oxygen. It is not surprising therefore that such a wide range of environmental factors was found throughout the collection of water samples and that ostracods were almost universally present in the collections.

Suborder PODOCOPA

Family CYPRIDAE: Subfamily CYPRINAE

Genus **Candonopsis** Vavra, 1891

Thin shelled forms, laterally compressed. Anterior antennae slender; posterior antennae, with penultimate segment subdivided, poorly developed natatory setae. Terminal segment of mandibular palp greatly produced. Maxillipeds with vibratory plate bearing three, thick, plumose setae; palp in male transformed into a prehensile organ for copulation. Dorsal margin of furca without setae. This genus contains only six species, all but one of which have been reported only from the Southern Hemisphere.

Candonopsis anisitsi Daday

Fig. 6

Candonopsis anisitsi Daday, Zool. **44:** 256, pl. 16, figs. 16–19, 20–26. 1905.

Specific characters.—Female: From the side elongated, height equal to about half the length; highest about three-fourths of the length from the anterior end. Dorsal margin gently rounded and sloping anteriorly; ventral margin indented. Anterior extremity somewhat less broadly rounded than posterior. From above, narrowly compressed. Terminal setae of third thoracic leg of equal length. Furca sixteen times longer than narrowest width; terminal and dorsal setae absent. Length 0.97–1.08 mm, height 0.48–0.53 mm. Color of preserved specimen, light.

Male: Similar to female in shape and structure of appendages. Height of shell somewhat greater in relation to length than female. Length 1.00–1.20 mm.

Remarks.—This species may easily be taken for *C. kingsleyi* on superficial examination but may be distinguished by the equal length of the terminal setae of the third thoracic leg.

Occurrence.—Males and females were found in all but four of the eleven widely separated areas which were sampled on the island of Jamaica. These areas were as follows: Portland Parish at an altitude of less than 1,000 feet, largely noncalcareous region on July 18 to July 24, 1952; the Wagwater River, just above Hermitage Dam, St. Andrews, at an elevation of 1,500 feet, noncalcareous region on July 31, 1952; Juan de Bolas, elevation 2,500 feet, noncalcareous region on August 1 to 7, 1952; near Christiana in Manchester Parish, elevations 3,000 feet, limestone region, on August 9 to 11 and August 27 to 29, 1952, and September 3, 1952; near Lucca, in the northwest portion of the island, in Westmoorland Parish, at a slight elevation, calcareous region, on September 1, 1952, near Mocho in the west central portion of the island, limestone region, elevation 2,000 feet, on August 15 and 18, 1952; and at the base of the John Crow Mountains near Eccelstown in the northwest corner of the island at 800 feet elevation, a calcareous region, on September 8, 1952. The species is evidently widely distributed over most of the island. It was not found at the higher elevations in the Blue Mountains nor in the north central portion.

Distribution.—The species was previously known only from Paraguay, where they were collected from pools formed by inundations of rivers.

Family CYTHERIDAE

Genus **Metacypris** Brady and Robertson, 1870

Shells very broad and short; seen from the dorsal view, width about three-fourths the length. First antennae with five or six segments; second antennae 4-segmented; exopodite jointed. Mandibles with obscurely segmented palp. Maxilla with three masticatory processes and a short palp; branchial plate without aberrant or orally directed setae. Furca of female with three setae.

Metacypris bromeliarum (F. Müller)

Fig. 8

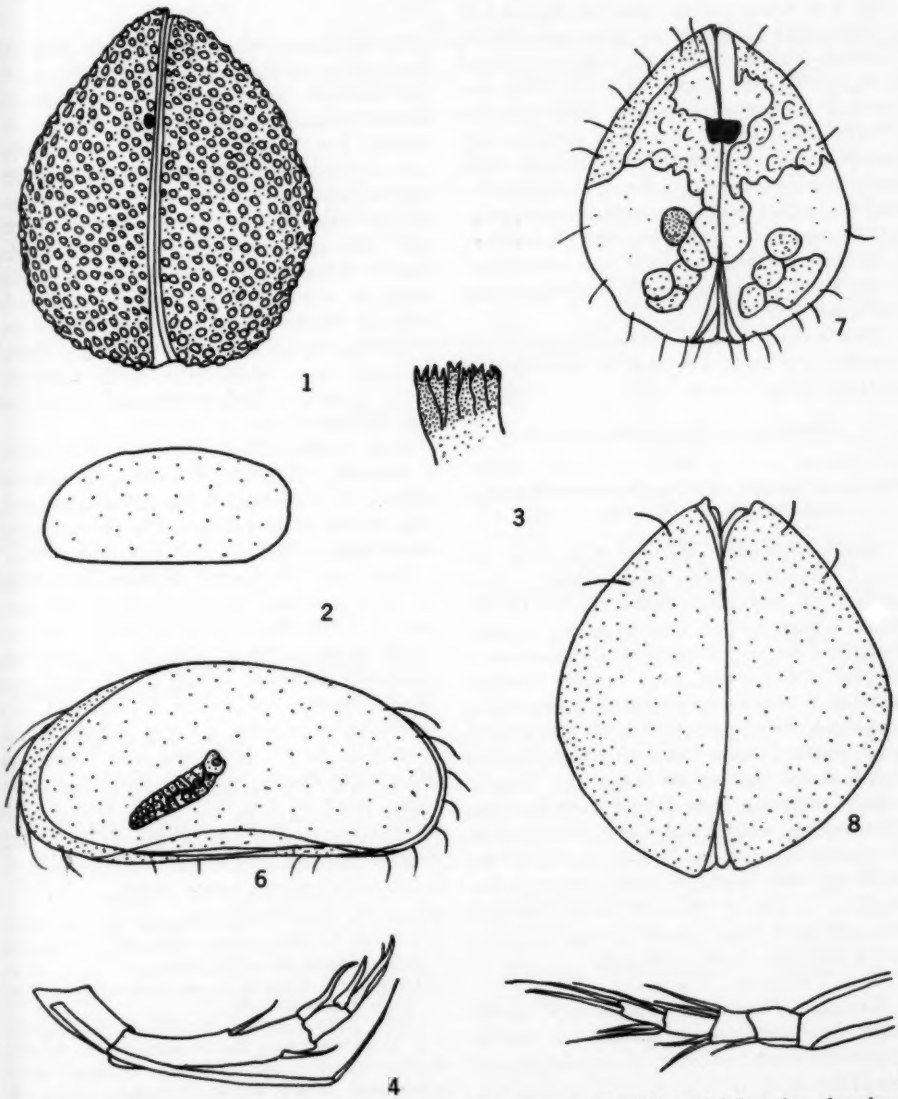
Elpidium bromeliarum F. Müller, Arch. Mus. Nac. Rio de Janeiro **4:** 27. 1881.

Metacypris bromeliarum G. W. Müller, Das Tierreich **31,** Ostracoda: 316. 1912.

Specific characters.—Female: Seen from the side, ovoid, height five-eighths length, highest in middle; anterior extremity considerably less broadly rounded than posterior; dorsal margin arched, sloping steeply to anterior end; ventral

margin almost straight. Seen from above, very tumid, width four-fifths length; anterior end slightly more pointed than posterior. Surface of valves smooth with no pits and few hairs. Color brown. First antenna with five segments; dorsal border of first segment terminates in a thickly haired wart; spine on second segment reaches to middle of fourth segment. Second antenna with exopodite reaching to tips of terminal claws. Mandibular teeth, seven, not split. Length 0.84 mm, height 0.52 mm, width 0.74 mm.

Male: Unknown.



FIGS. 1–5.—*Metacypris laesslei*, n. sp.: 1, Dorsal view, female; 2, outline of left valve, female; 3, mandibular teeth, female; 4, second antenna, female; 5, first antenna, female. FIG. 6.—*Candonopsis anisitsi* Daday. FIG. 7.—*Metacypris maracaoensis* Tressler. FIG. 8.—*Metacypris bromeliarum* (F. Müller).

Occurrence.—Females were widely distributed over the island being found in all but two of the eleven areas sampled. These locations were as follows: Portland Parish at an elevation of less than 1,000 feet, a largely noncalcareous region on July 18 to 24, 1952; Wagwater River, just above Hermitage Dam, St. Andrews, elevation 1,500 feet, noncalcareous region on August 1 to 7, 1952; near Christiana in Manchester Parish, elevation 3,000 feet, limestone region on August 9 to 11, 1952, and August 27 to 29, 1952; near Lucea in the northwest portion of the island in Westmoorland Parish, at a slight elevation, calcareous region, on September 1, 1952; near Nigril in the extreme western portion of the island at a slight elevation, calcareous region on September 2, 1952; and at the base of the John Crow Mountains near Ecclestown in the northeast corner of the island, elevation 800 feet, calcareous region on September 8, 1952.

Distribution.—This species has previously been reported only from leaf cups of bromeliads in southern Brazil.

Metacypris maracaoensis Tressler

Fig. 7

Metacypris maracaoensis Tressler, Journ. Washington Acad. Sci. **31** (6): 268. 1941.

Specific characters.—Female: Seen from the side, oval in shape with greatest height about one-half the length and highest in the middle. Dorsal margin arched; ventral margin straight. Posterior extremity more broadly rounded than anterior. From above, very broadly rounded posterior extremity and pointed anterior end. Large eyes, fused. Surface of valves smooth with a few scattered hairs. Color gray with a much darker area in the anterior half of the valve. A mass of polygonal areas in vicinity of the eyes. First antenna with five segments, the spine on the second segment reaching to middle of the fourth segment. Second antenna with exopodite reaching to tips of terminal claws. Mandible with eight teeth which are split. Length 0.72 mm, height 0.37 mm, width 0.65 mm.

Male: Unknown.

Remarks.—This species is similar to *M. cordata* but is larger, the valves are without pits, and the mandibular teeth are different, numbering only four or five in *M. cordata.*

Occurrence.—Numerous females were collected from bromeliad leaf cups near Immokalee, Collier County, Fla., in July 1953.

Distribution.—This species is known only from a similar habitat in the Maracao National Forest, Puerto Rico, where it was collected at an elevation of between 2,800 and 3,000 feet in January and December.

Metacypris laesslei, n. sp.

Figs. 1–5

Specific characters.—Female: Seen from the side, oval in outline, height equal to about five-eighths length, highest in middle. Dorsal margin arched, ventral margin straight. Anterior extremity less broadly rounded than posterior. From above, width equal to six-sevenths length, anterior end somewhat pointed, posterior end broadly rounded. Surface of valves covered with small pits and a few hairs. Color brown with darker brown spots. First antenna with five segments; spine on second segment reaches to terminal fourth of fourth segment. Second antenna with exopodite barely reaching to tips of terminal claws. Mandibular teeth split and seven in number. Length 0.78 mm, height 0.49 mm, width 0.66 mm.

Male: Unknown.

Remarks.—This species is similar in size and shape to *M. maracaoensis* but differs in the presence of pits on the valves and in the number of mandibular teeth.

Occurrence.—Numerous females were found in three locations on the island of Jamaica, namely, in the Blue Mountains in St. Andrews Parish at an elevation of 3,200 to 4,000 feet, noncalcareous region, on July 3 to 9, 1952; near Mocho, west-central portion of the island, in a limestone region at an elevation of 2,000 feet on August 15 to 18, 1952; and near Christiana, Manchester Parish, elevation 3,000 feet, limestone region, on August 27 to 29, 1952. Female holotype, U. S. N. M. no. 99387. Type locality, Blue Mountains, St. Andrews Parish, Jamaica.

LITERATURE CITED

DADAY, E. VON. *Untersuchungen über die Süsswasser - Mikrofauna Paraguays.* Zoologica (Stuttgart) **44:** 1–374. 1905.

MÜLLER, F. *Wassertiere in Baumwipfeln.* Kosmos **6:** 386–388. 1880.

———. *Descripsão do* Elpidium bromeliarum. Arch. Mus. Nac. Rio de Janeiro **4:** 27–34. 1881.

PICADO, M. C. *Les bromeliaces epiphytes considerees comme milieu biologique.* Bull. Sc. France Belgique (7) **47:** 215–360. 1913.

TRESSLER, W. L. *Ostracoda from Puerto Rican bromeliads.* Journ. Washington Acad. Sci. 31 (6): 264–269. 1941.

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